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ABSTRACT

This handbook was prepared to help science teachers, administrators, and other school staff members understand and avoid situations in which accidents might occur in the science laboratory, on field trips, or during outdoor education experiences. Suggestions contained in this publication are generally agreed upon and recommended for consideration by all California science teachers. Because this publication was prepared for statewide distribution, not all of the recommended policies are appropriate for adoption in all school districts. Ideas may be adapted to meet the needs of teachers and students in each district. This publication is designed for use by laboratory instructors and therefore provides minimal information directed towards students, parents, and administrators about necessary safety procedures in the science laboratory. Some materials such as parental consent forms and sample student safety contracts have been included in the appendices to help teachers communicate with other audiences. Topics include: (1) "First Aid"; (2) "General Laboratory Safety Precautions"; (3) "Safety in the Biology Laboratory"; (4) "Safety in the Chemistry Laboratory"; (5) "Safety in the Physics Laboratory"; and (6) "Safety Practices". (Author/SOE)

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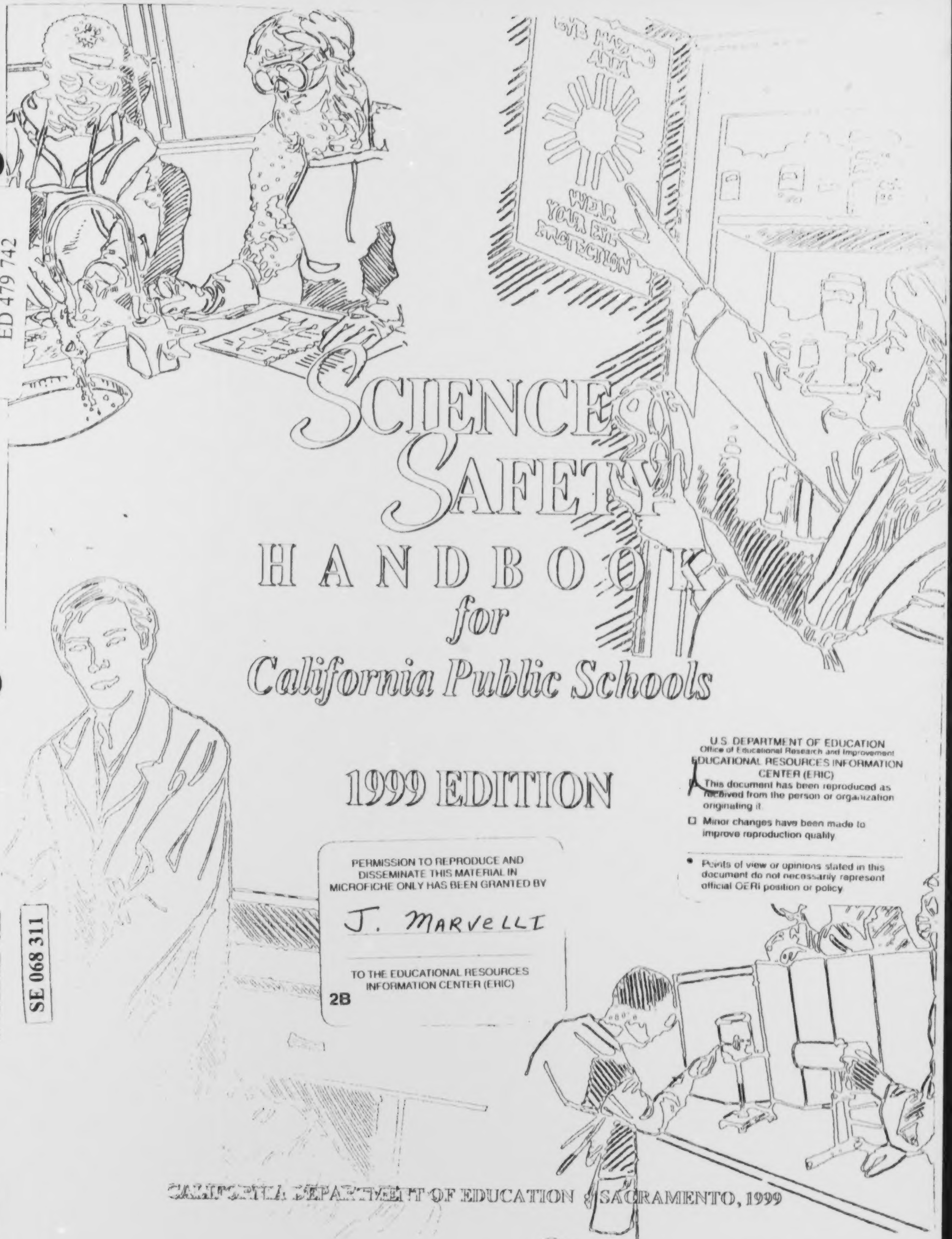

SCIENCE SAFETY HANDBOOK for California Public Schools

1999 EDITION

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SCIENCE SAFETY HANDBOOK for California Public Schools

1999 EDITION

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A partial list of other educational resources available from the Department appears on page 178. In addition, a catalog describing publications, videos, and other instructional media available from the Department can be obtained without charge by writing to the address given above or by calling the Sales Office at (916) 445-1260.

Notice

The guidance in the *Science Safety Handbook for California Public Schools* (1999 Edition) is not binding on local educational agencies or other entities. Except for the statutes, regulations, and court decisions that are referenced herein, the document is exemplary, and compliance with it is not mandatory. (See *Education Code* Section 33308.5.)

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SCHOOL DISTRICT EMERGENCY AND SAFETY PROCEDURES

***Note:* Procedures discussed in this handbook involve potential dangers to persons, animals, and other living things and, therefore, should be performed only by persons who are technically trained and qualified.**

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SCHOOL DISTRICT EMERGENCY AND SAFETY PROCEDURES

Note: Insert a copy of your school district's emergency procedures and your school's chemical hygiene plan (*California Code of Regulations, Title 8,* General Industry Safety Orders, Section 5191). Include evacuation plans, hazardous materials spill procedures, and so forth. Enter your important local telephone numbers here.

Important Telephone Numbers

Standard Emergency Number	**911**
Ambulance Source	______________
Animal Control (Pound)	______________
California Division of Industrial Relations (Safety Concerns)	______________
City/County Health Department	______________
District/County Science Specialist ______________ (Name)	______________
District Safety Officer ______________ (Name)	______________
Fire Department	______________
Hospital ______________ (Name)	______________
Regional Poison Center (see Appendix E)	______________
Police/Sheriff	______________
School Health Service	______________
Toxic Substances Control Office	______________
______________ (Contact for Chemical Disposal)	______________
______________ (Other)	______________

1

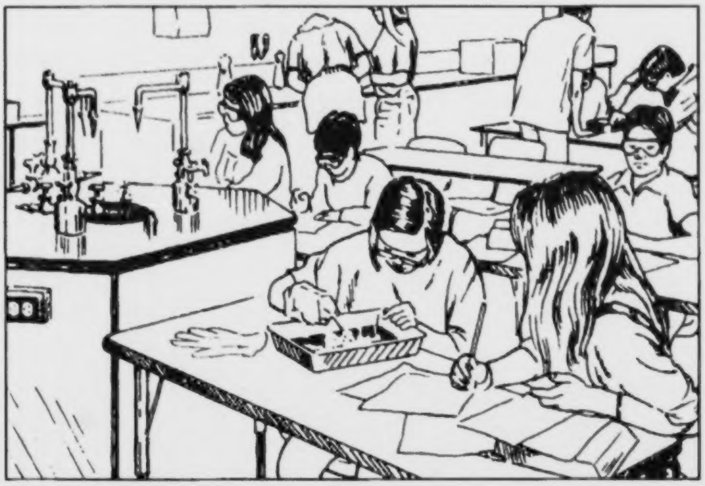
INTRODUCTION

A. Responsibilities of Students and Parents **2**
B. Reasonable Laboratory Class Size **2**
C. Teacher's Liability **4**
D. State and Federal Legislation Affecting Science Instruction **5**

Note: **Procedures discussed in this handbook involve potential dangers to persons, animals, and other living things and, therefore, should be performed only by persons who are technically trained and qualified.**

1. INTRODUCTION

LABORATORY ACTIVITIES AND DEMONSTRATIONS represent an essential part of effective science teaching. Written materials and pictures can convey an enormous amount of information, but students more fully understand the concepts related to science when they participate in or observe learning activities involving laboratory experiments and demonstrations. In addition, those activities allow students to learn the processes and techniques of science laboratory investigation. Students who go to colleges and universities and take advanced science courses are expected to know laboratory procedures. The *Science Framework for California Public Schools, K–12*, specifies that "of the total time spent learning science, at least 40 percent should be involved in activity-based lessons."[1] This concept applies in kindergarten through grade twelve.



Although many science activities present potential hazards, reasonable and prudent safety practices greatly reduce the likelihood of accidents. When students adhere strictly to standard safety precautions, they are unlikely to encounter any risks greater than those they might encounter in physical education, vocational education, or home economics classes. Knowing about possible hazards and taking precautions are the basis for creating a safe learning environment. All students studying science benefit from practicing safety procedures and from learning to appreciate scientific methods. The National Science Teachers Association (NSTA) promotes extensive use of laboratory investigations and field trips in science instruction and urges that "school districts and teachers should share the responsibilities of establishing safety standards and seeing that they are adhered to."[2]

Science teachers must be advocates of safety and have the information and attitudes necessary to inform community and school groups and involve them in support of activity-based science classes. School administrators and district administrative staff must be active supporters of hands-on science experiences. Administrators must be kept informed of laboratory activities and concomitant safety precautions and must devote resources to make such experiences possible. Parents, too, must be aware of and approve the laboratory experiences their students will have.

Science teachers are in a unique position to orient school administrators to the attitudes, skills, rational thinking processes, and knowledge resulting from laboratory activities. Many science laboratory exercises use readily available materials and may be inexpensive to conduct. This information should be conveyed to administrators to increase their appreciation of the number, variety, and cost effectiveness of experiments. The main point is that administrators who observe student motivation resulting from laboratory participation will be more likely to increase their support for activities requiring more resources. To ensure that support, science teachers will need to provide evidence that appropriate safety precautions have been taken. This emphasis on safety is reflected in the guidelines of the International Science and Engineering Fair (ISEF), which has established rules that are "intended to ensure the safety of students, to protect the subjects and environments studied, and to limit the liability of the adults who assist with the projects."[3]

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[1] *Science Framework for California Public Schools, K–12*. Sacramento: California Department of Education, 1990, p. 160.

[2] "Liability of Teachers for Laboratory Safety and Field Trips," in *NSTA Handbook, 1994-95*. Arlington, Va.: National Science Teachers Association, 1994, p. 242. See a reprint of this position statement in Appendix A.

[3] "ISEF Operational Guidelines for Scientific Review Committees and Institutional Review Boards." Included with the *International Rules for Precollege Science Research: Guidelines for Science Fairs, June 1995–May 1996*. Washington, D.C.: Science Service, Inc., 1995.

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A Responsibilities of Students and Parents

Through their own educational background and training, most science teachers have learned to use safe laboratory techniques as a matter of course. Because many students have not had the opportunities at home and in school to observe and practice safety procedures, the science laboratory is a good place to begin learning the fundamentals. Students have a responsibility to themselves and their classmates to learn and observe safety practices in all participatory science activities. In addition, students should adopt positive attitudes about the need for safety in a laboratory setting. Students' interest in science activities must be channeled constructively so that capricious, careless actions do not occur.

The following practices, skills, or areas of knowledge are among the issues dealt with in this handbook and should be taught in most laboratory classes (see also Appendix B, *Education Code* Section 51202):

- Proper eye-care safety practices
- Proper handling of glassware and glass tubing
- Proper setup and handling of electrical equipment
- Safe use of chemicals in the laboratory
- Correct methods for storing, handling, and disposing of surplus, waste, and deteriorated chemical substances
- Appropriate, safe use of heat sources in the laboratory
- First-aid procedures
- Prompt notification to appropriate individuals or agencies of any dangerous or potentially dangerous conditions
- Appropriate, safe, and humane treatment of animals
- Prohibition of the use or presence of any venomous animals, poisonous plants, or plant pests
- Proper fire prevention and control techniques
- Correct methods for cleanup after experiments
- Proper behavior and courtesy in a laboratory situation
- Earthquake-safe behavior and evacuation routes

Parents should be aware of the kinds of science laboratory activities that will be conducted and be encouraged to sign consent forms for their children's participation. The consent forms (see examples included in appendixes F, J, and P) do *not* constitute a legal release from joint and several liability but are a way of informing parents that safety procedures exist at school and are a part of the students' safety training. Consent forms should be considered contracts for partnership, not abdication of control. Parents are welcome in the science laboratories, just as they are in other classes. (Of course, they will have to wear protective goggles and follow other safety procedures expected of the students.) Parents are encouraged to support the school science program and to reinforce the curricular objectives of the course through family activities, such as museum visits, field trips, and so on. Parents of students participating in science fairs should expect to work with the teacher to ensure that safety procedures are understood and adhered to by all.

B Reasonable Laboratory Class Size

No current legal mandate prescribes special limits on class size in science laboratories. The *Uniform Fire Code* classifies science laboratory classes as academic subjects and specifies 20 square feet per student as a minimum standard, in contrast to a vocational education class for which the requirement is 50 square feet per student. In reality, more than 20 square feet per pupil are required for hands-on laboratory science activities. That criterion is reflected in *California Code of Regulations, Title 2,* Section 1811(g)(2), which requires the state architect to design laboratory classrooms for occupancy by 26 students in grades seven through twelve or 24 students in grades nine through twelve. *These design specifications are generally* understood by state and local agencies to be equivalent to 1,300 square feet of floor space, including preparation and storage areas.

Therefore, teachers and administrators need to take several considerations into account in establishing reasonable limits on the number of students in a laboratory setting to ensure maximum safety within the science laboratory. These considerations include:

1. The space required for each student to perform experiments safely
2. The safety features in the design of the facilities or space
3. The level of maturity and safety knowledge that students bring to the science laboratory
4. The number of students that one teacher can supervise during a potentially dangerous activity
5. The nature and degree of increased hazard and liability when the class size exceeds 24 students

One of the *Science Framework* guidelines applying to safe conditions for science instruction encourages the practical attitude that "the number of students in the laboratory classroom should be determined by factors such as safety, number of stations, and total classroom square footage, rather than school scheduling needs."[4]

Laboratory Capacity

Faculty cannot be expected to monitor an overcrowded laboratory when potentially hazardous experiments are being conducted. No one, whether student, teacher, or administrator, wants the increased risk of having too many students in a science laboratory class. But overcrowding still occurs. It is a difficult risk-benefit decision for school administrators to set limits on laboratory class size. However, if a large number of students must be placed in an inadequately designed facility, there are ways to provide supervisory assistance for the teacher. An obvious alternative is to add an advanced high school student, a college student, or a retired science specialist as an aide (monitor) during the potentially hazardous laboratory period; or other teachers may be willing to help supervise the laboratory. Another alternative is to schedule additional laboratory sections to reduce the class size. Teachers should express their safety concerns, in writing, to their department chairperson and school-site administrator. Under no circumstances *should laboratory instruction proceed when the* number of participating students exceeds the design capacity of the laboratory.

Students' Safety Experience

In determining laboratory class size, the teacher, department head, and principal should assess the students' backgrounds in relation to safety. Some groups of students come to the science laboratory with safety training; these groups include students from previous science (laboratory) classes and from many vocational education courses. Students who have been instructed in safety and first-aid procedures are less at risk than those who lack such training. In addition, some groups of students demonstrate a more mature capacity for greater responsibility and, therefore, allow a greater sense of security in the laboratory. Section A of this introduction addresses the students' responsibility to learn safety practices; the materials in the references and appendixes provide the teacher with additional help in preparing students for safety.

Facilities

No amount of student screening can make up for overcrowded or potentially unsafe laboratory settings. A primary concern is the physical distance between students and between work stations in the laboratory. Many school laboratory stations that are designed for two pairs of students add a fifth student in the aisle. This practice crowds the students and blocks traffic lanes, inviting accidents and preventing orderly evacuation and administration of first-aid procedures.

Most laboratories were designed for a specific number of students, and that number should not be exceeded. For example, a chemistry classroom with a single vented hood was not designed for volatile toxic chemicals to be tested simultaneously by 30 or more students. Therefore, prudent planning of the laboratory program is necessary. Similarly, laboratories with single or distant eyewash and first-aid stations cannot accommodate multiple injury or emergency victims. Alternative actions must be considered.

Teachers are encouraged to work with their administrators to identify and alleviate potential hazards due to overcrowding and limitations in facilities. The objective should be to guarantee the safest possible environment in which to conduct experiments without reducing the number or quality of activity-based science lessons.

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[4] *Science Framework,* p. 178.

C Teacher's Liability

Laws and regulations at the national, state, county, city, and school district levels are explicit enough to place direct responsibility on teachers, administrators, school board members, and school district science specialists for the safety of students in science classrooms. In the existing climate of accountability and liability for the safe conduct of educational processes, the science teacher comes under close scrutiny. Although protected to a degree by a school district's legal resources, the teacher is vulnerable to professionally and personally damaging lawsuits.

It is important to plan preventive steps that will minimize accidents and reduce both individual and district liabilities. Essentially, such steps include effective safety instruction, careful supervision of all activities, and proper maintenance of laboratory and classroom equipment. Because school districts and the classroom instructors, on occasion, may become involved when students are injured or negligence occurs, staff should recognize that the court examines the circumstances and conduct of the responsible individuals to ascertain whether their conduct, actions, judgment, and behavior were reasonable and prudent under the given circumstances. Through an analysis of the actions taken by the school, the school district, and the individual, the court determines the degree of responsibility that can be attributed to the parties involved. The court also tests individuals, using the "reasonable man" rule, to determine whether the individual exercised the proper degree of caution and judgment that an average person of his or her training and background would have exercised under similar circumstances. (See Appendix A for [1] sample cases testing the liability of science teachers; and [2] the NSTA's position statement titled "Liability of Teachers for Laboratory Safety and Field Trips.") Fortunately, many resources exist to help teachers gain expertise in safe ways of conducting demonstrations and laboratory activities.

Posting safety guidelines and procedures (suggested or sample study sheets for safe use of chemicals, lasers, heating, and so on) is a recommended practice for science classrooms, but the courts have declared posting to be insufficient, in and of itself, to ensure students' safety. The science teacher must continually remind students of both general and specific hazards before the performance of laboratory activities in which any element of danger might exist. If a textbook or laboratory manual specifies a dangerous procedure, which neither the students nor the instructor can reasonably carry out, then the teacher must ensure that the procedure is not followed but is replaced with a safe one. Students should not be allowed unsupervised access to potentially dangerous materials or equipment and should be under continual supervision in all laboratory situations (for the safety of both student and equipment). Monitoring or supervising a laboratory setup during passing periods is an essential consideration.

Specific safety instruction and testing are highly recommended as an integral part of every science classroom procedure. This handbook includes suggested safety procedures and a student safety test that may be adapted for use in the teaching of various scientific disciplines (see Chapter 3 and Appendixes F, G, J, and P). The checklist in Appendix H will be helpful in assessing the safety features of classroom/laboratories, preparation areas, and storerooms. And the "Science Laboratory Safety/Liability Checklist" in Appendix L is designed to assist department chairs and administrative staff in evaluating the effectiveness of facilities and established procedures regarding accident prevention and the potential liability of the school or school district.

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D State and Federal Legislation Affecting Science Instruction

Legislative enactments since 1982 have had a significant impact on safety in science instruction and on the duties of science teachers. The following are the topics of those enactments:

1. Hazardous materials education (*Education Code* Section 49340 et seq.)
2. Removal of chemicals (*Education Code* Section 49411)
3. Occupational exposure to hazardous chemicals in laboratories; chemical hygiene plan (*California Code of Regulations, Title 8,* General Industry Safety Orders, Section 5191)
4. Bloodborne pathogens (*California Code of Regulations, Title 8,* General Industry Safety Orders, Section 5193)
5. Hazard communication; material safety data sheets (*California Code of Regulations, Title 8,* General Industry Safety Orders, Section 5194)
6. Repeal of requirement for obtaining an extremely hazardous waste disposal permit (*Health and Safety Code* Section 25153)
7. Hazardous materials release response plans and inventory (*Health and Safety Code,* Chapter 6.95, Section 25500 et seq.)

Significant excerpts of these (and other) laws are cited in Appendix B. Summaries of the recent enactments are provided below:

1. Hazardous materials education (*Education Code* Section 49340 et seq.)

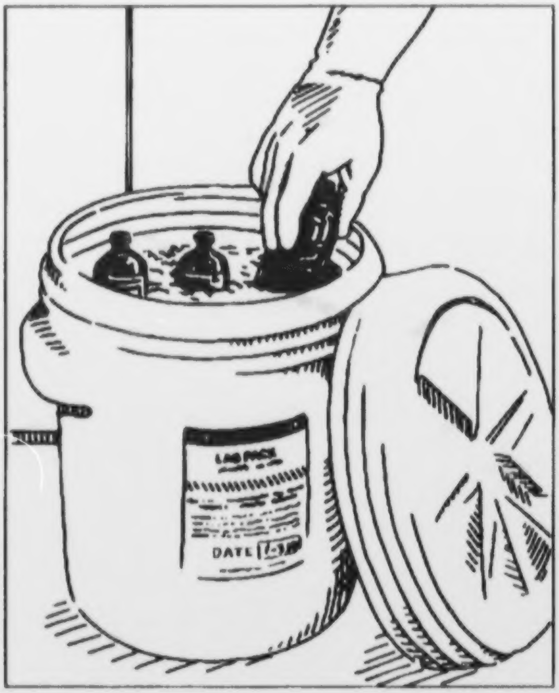
   This legislation recognizes the potentially hazardous nature of materials and procedures used in school science laboratories and the need for educators to increase the awareness of persons dealing with the materials to minimize the dangers. Each school is encouraged to designate a trained member of its professional staff as the building laboratory consultant responsible for reviewing, updating, and carrying out the school's adopted procedures for laboratory safety.

   The Legislature urges the California Department of Education to assume the leadership necessary to provide qualified individuals with the skills and materials to assist schools and teachers in the development of their laboratory safety policies and procedures.

   School districts are encouraged to take steps to ensure that hazardous materials are properly used and stored; the governing boards may request consultation services from the California Occupational Safety and Health (Cal/OSHA) Consultation Service.

2. Removal of chemicals (*Education Code* Section 49411)

   The California Department of Education, in cooperation with the Division of Occupational Safety and Health, shall prepare a list of chemicals used in school programs that includes the potential hazards and estimated shelf life of each chemical or chemical compound and develop guidelines for school districts for the regular removal and disposal of all chemicals whose estimated shelf life has elapsed.



   The county superintendent of schools may implement a system for disposing of chemicals from schools within the county or may permit school districts to arrange for the disposal of the chemicals.

   Note: School districts and county departments of education can request reimbursement for the costs of implementing and maintaining a program for the regular removal and disposal of all chemicals

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whose shelf life has elapsed, in accordance with the guidelines, *if they certified to the Superintendent of Public Instruction by June 30, 1988, that the district was in compliance with the guidelines.* See Appendix C for more information on reimbursable costs and details for filing claims for reimbursement.

3. Occupational exposure to hazardous chemicals in laboratories; chemical hygiene plan (*California Code of Regulations, Title 8,* General Industry Safety Orders, Section 5191)

   This legislation requires all employers engaged in the laboratory use of hazardous chemicals to take specific action toward minimizing employee exposure to such chemicals. Employers must develop a chemical hygiene plan that includes:

   - Safe operating procedures
   - Protective equipment
   - Maintenance of proper labeling on hazardous substances
   - Retention of all MSDSs received from vendors; MSDSs to be made available to employees
   - Employee information and training
   - Provisions for medical consultations and examinations
   - Designation of a chemical hygiene officer to implement and maintain the plan

   Employee information and training on the hazards of chemicals present in the work area shall be provided at the time of an employee's initial assignment to his or her work area and prior to assignments involving new exposure situations. Refresher information and training shall be provided at intervals determined by the employer.

   The chemical hygiene plan shall be readily available to employees, employee representatives, and, on request, the Chief of the Division of Occupational Safety and Health.

4. Bloodborne pathogens (*California Code of Regulations, Title 8,* General Industry Safety Orders, Section 5193)

   This regulation applies to all employers whose employees are subject to reasonably anticipated exposure of their skin, eyes, or mucous membranes, or through parenteral contact, to blood or other potentially infectious materials as a result of the performance of the employees' duties. Employers are required to establish a written exposure control plan (ECP) designed to eliminate or minimize employee exposure. The ECP must contain at least the following elements:

   - Determination of employees who may be exposed to bloodborne pathogens (school nurses, physical education teachers, school security personnel, science teachers)
   - Methods of compliance (engineering and work practice controls, personal protective equipment, houskeeping procedures)
   - Hepatitis B vaccination
   - Postexposure evaluation and follow-up
   - Hazard communication information (labels and signs) and training
   - Recordkeeping

   Because science classes include a variety of hands-on laboratory activities in which the use of glassware and sharp instruments may result in cuts and abrasions, science teachers should be an integral part of and in compliance with their school's exposure control plan.

5. Hazard communication; material safety data sheets (MSDS) (*California Code of Regulations, Title 8,* General Industry Safety Orders, Section 5194)

   According to Section 5194 of the General Industry Safety Orders, laboratories not engaged in either production of hazardous substances for commercial purposes or provision of quality control analysis for production processes are partially exempt from the requirements of obtain-

MATERIAL
SAFETY
DATA
SHEETS

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ing a material safety data sheet (MSDS) from the manufacturer, of complying with the written hazard communication program, and of labeling containers (except as required by other safety orders regulating labels) when all the following conditions are satisfied: (1) all exposed employees (professional, technical, janitorial, and maintenance) are under the direct supervision and regular observation of an individual who has knowledge of the physical and health hazards and emergency procedures involved; and (2) the supervisor *conveys this knowledge to employees in terms of safe work practices.* Such exempted laboratories must also ensure that labels of incoming containers of hazardous substances are not removed or defaced and must maintain any MSDSs that are received with incoming shipments of hazardous substances and ensure that those MSDSs are readily available to laboratory employees.

6. Repeal of requirement for obtaining an extremely hazardous waste disposal permit (*Health and Safety Code* Section 25153)

   No special or additional permits are now required for the storage, treatment, transportation, and disposal of extremely hazardous waste. Such waste is subject to the same requirements as hazardous waste.

   Producers and transporters of extremely hazardous waste are required, on an annual basis, to notify and to send a tax return to the Board of Equalization. On receipt of a bill from the Board, the business is to pay an annual fee.

7. Hazardous materials release response plans and inventory (*Health and Safety Code*, Chapter 6.95, Section 25500 et seq.)

   The code requires every county to implement, through a designated administering agency, existing law providing for a governmental response to a release or threatened release of hazardous substances. (A city could assume that responsibility within its boundary.)

   Any business which handles a hazardous material must establish a specified business plan, in accordance with the standards of the Office of Emergency Services, for emergency response to a release or threatened release of the hazardous material.

   Any business which handles a hazardous material must submit a specified inventory annually to the administering agency.

   Pursuant to the provisions of Section 25503.5, businesses which have less than 500 pounds or less than a total of 55 gallons or 200 cubic feet, at standard temperature and pressure (for compressed gas), of a hazardous material may be exempt from establishing and implementing an emergency response plan.

   Note: A handbook entitled *Guide to Hazardous Substances Reporting Requirements* was developed in 1991 by the California Environmental Protection Agency (Cal/EPA) and the Chemical Emergency Planning and Response Commission to help organizations comply with this legislation. Copies are available for $30 each from:

   Cal/EPA Environmental Information
   555 Capitol Mall, Suite 3525
   Sacramento, CA 95814

   Make checks payable to Environmental Information.

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2

First Aid

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C. Burns **11**
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E. Exposure to Poisons **13**
F. Cardiopulmonary Resuscitation (CPR) **14**
G. Shock **15**

***Note:* Procedures discussed in this handbook involve potential dangers to persons, animals, and other living things and, therefore, should be performed only by persons who are technically trained and qualified.**

2. FIRST AID

UNDER NORMAL CIRCUMSTANCES THE SCHOOL nurse will direct the activities necessary for treatments of illness, injury, or other health problems of students. However, at times the nurse may not be available for first aid on the school premises because his or her other responsibilities may include making home calls, transporting students, and engaging in health education duties. At those times the teacher needs to take appropriate action. Each science classroom should be equipped with appropriate first-aid and safety materials (see Appendix D).

EMERGENCY
FIRST AID
STATION

A General Information

If a student becomes ill or is injured, the teacher is expected to act in an informed and objective manner, with a minimum of emotional expression. The teacher needs to evaluate the problem, with special attention to the following symptoms:

- Difficulties in breathing—Start artificial respiration if breathing is absent; obtain a trained person to give CPR, if needed.
- The presence of bleeding—If necessary, control the bleeding in compliance with the school's bloodborne pathogens exposure control plan.
- The presence of shock—If necessary, initiate treatment.

Once assistance is given, it should be continued until the problem is resolved or until the patient is released to qualified medical help, the parent, or another responsible person. Measures should be taken to reduce any anxiety or fear that the injured student or other students may experience. A written accident report should be given to the school-site administrator when any such incident occurs; see Appendix D for a sample Accident Report.

Do's in First Aid

1. *Do* be cool, calm, and collected. Most cases are not serious.
2. *Do* obtain staff assistance, if necessary.
3. *Do* handle the person as little as possible. Do not move the person until the evaluation is complete.

On completion of the emergency-handling phase:

4. *Do* check with the victim and with any witnesses about what happened.
5. *Do* make a prompt, complete, and accurate report of the incident to the department chairperson and the administration.
6. *Do* be concerned with injuries that occurred on the way to and from school as well as those that occur at school.

Don'ts in First Aid

1. *Don't* give liquids (or medicines) to an unconscious person.
2. *Don't* try to arouse an unconscious person.
3. *Don't* cut the skin, break blisters, and so forth.
4. *Don't* diagnose.
5. *Don't* give medical advice.
6. *Don't* reduce dislocations.
7. *Don't* transport an injured student in a private car.
8. *Don't* send a student home before consulting a parent.
9. *Don't* treat injuries that happened at home.

B Bites by Snakes, Spiders, Insects, and Mammals

Rattlesnakes are the most common naturally occurring poisonous snakes in California. They are common in canyons, mountains, deserts, and new construction areas. Few adolescents or adults die from rattlesnake bites, although such bites inflicted on small children are considered especially serious. Bites by insects seldom result in death, but the ensuing pain and discomfort may be minimized by early intervention. Dogs often come onto the school grounds and bite students, and human bites occasionally occur in schools. Such bites often become infected and should be referred to a physician for treatment and continued observation.

Poisonous Snake Bites

1. The victim should be kept at absolute rest. Transport the victim to a source of medical attention as soon as possible. Treat for shock.
2. Incision of the wound is dangerous and should be undertaken only by medical professionals. An incision is a surgical procedure that should be performed by trained specialists. A sterile field and sterile instruments must be used.
3. The major effort of the teacher should be to quiet the victim and effect immediate transportation to the nearest medical facility in which an expert evaluation can be followed by the most appropriate action. When any wound that is caused by a poisonous snake occurs on school premises, expert emergency-room help would be close enough so that a teacher would not have to perform an incision.
4. Poison information centers recommend the following steps:
    a. Keep the victim still. Transport to medical care as soon as possible.
    b. Place the injured extremity in a lowered position to retard the flow of the toxins to the victim's heart.
    c. Apply a constricting band 2 to 4 inches (5 to 10 cm) above the wound if the bite is on the arm or leg. The band should be snug but loose enough to allow blood to flow to the limb.
    d. Cool the extremity with cold compresses, if possible, until the person arrives at the hospital but do not pack the wound in ice.
    e. Do not cut the wound area. A person injured at school is usually within one hour of being admitted to an emergency room and receiving expert care.

Spider Bites

1. Use a cold application and apply soothing lotions, such as calamine lotion.
2. Refer a student with black-widow spider bites to the nurse and the student's parents for medical attention. Generally, the bites are not considered to be medically urgent unless the school nurse alerts you that the student has had an allergic reaction.

Bee Stings

1. Observe the person for an allergic reaction while carrying out steps 2 through 6 described below. Some of the signs to look for would be:
    - Difficult breathing
    - Dry, hacking cough
    - Swelling and itching about the eyes
    - Sense of constriction in the throat or chest
    - Massive rash
    - Sneezing and wheezing
    - Sense of uneasiness

   These symptoms usually occur within minutes, and such victims should be seen by a physician right away. Occasionally, the reactions are delayed.
2. Remove the stinger by scraping it with a fingernail or the blunt edge of a knife. To avoid releasing more venom, do not squeeze the end of the stinger by pulling it out with your fingers.
3. Wash the area of the sting well with soap and water.
4. Cover the sting with moistened meat tenderizer containing the enzyme papain. (Check ingredients on the label for the word *papain*.)
5. Place an ice pack on the sting. Do not put ice directly on the skin. Use an ice bag or wrap ice in a cloth.
6. Seek medical evaluation if the swelling becomes severe. Observe for infection, especially if stung by a wasp or yellow jacket, both of which are known to carry bacteria.

Mammal Bites

There is danger of infection and rabies from the bites of all warm-blooded animals. Students should be advised not to approach strange dogs and other animals, especially a familiar pet that is acting peculiarly. Bats and skunks that are active in daytime must be considered rabid.

First-aid treatment consists of washing and flushing out the wounds thoroughly with strong warm soap or detergent solution as quickly as possible. Continue the washing for at least 10 minutes. The value of this procedure is greatest when performed during the first hour or two. Refer to parents for medical follow-up. Catch the animal, if that is deemed safe to do, and obtain information on the animal. Then call the local animal control agency.

C Burns

Because heat sources and corrosive chemicals are used in many laboratory science activities, there is the potential for burns to occur from either source. If someone is burned, the following procedures are appropriate:

Chemical Burns of the Skin (usually from strong acids or alkalies)

This kind of burn needs to be washed with large amounts of water. Use a shower or hose at *low* pressure (a forceful stream of water may further injure the burned skin) for at least 10 minutes. Remove clothing from the affected area while the skin is being flushed. Some chemical containers may suggest other helpful first-aid measures on the label; those may be used for that particular chemical. *Do not attempt to neutralize any chemical;* by doing so you may cause further chemical reaction and more damage. Apply a dressing and obtain medical aid by following the serious injury or illness routine.

Chemical Burns of the Eye

See section D, "Eye Injuries," in this chapter.

Nonchemical Burns of the Skin

The degree or extent of burns and the percentage of skin surface involved usually determine the first-aid measures to be used. In general, adults who have suffered burns over 10 percent of their body surface (or a child with 2 percent to 10 percent burns) require hospitalization. Burns on the face suggest possible injury to the respiratory tract and may obstruct breathing as facial swelling increases. *Prompt medical attention is imperative.*

First-degree burns mean minor burns, such as those resulting from overexposure to the sun or from light contact with a hot object. The usual signs are redness or discoloration together with mild swelling and pain. First aid includes cool water applications or submersion of the burned area in cool water for no longer than 10 minutes to stop the burning process. Follow with a dry dressing, if necessary.

Second-degree burns may result from a very deep sunburn, contact with hot liquids, or flash burns from flammable products. These burns are usually of greater depth than first-degree burns and have a red appearance. Blisters are usually present. First aid for second-degree burns entails (1) immersing the burned part in cool water (*not* in ice water) for a few minutes (water at room temperature or less is appropriate); (2) applying dry, sterile gauze or a clean cloth as a protective bandage; (3) taking precautions against breaking intact blisters or removing tissue; (4) avoiding an antiseptic preparation, ointment, spray, or home remedy if the burn is severe or covers more than 10 percent of the body; (5) keeping affected arms or legs elevated; and (6) seeking medical evaluation.

Third-degree burns may be caused by a flame, ignited clothing, immersion in hot water, grease scalds, contact with hot objects, or electricity. The temperature and duration of contact are important in determining the extent of tissue destruction. These burns are usually characterized by deep tissue destruction; white, dark brown, mottled, or charred appearance (at first, the burn may resemble a second-degree burn); and complete destruction of all layers of the skin. First-aid procedures for third-degree burns are as follows:

1. Extinguish any smoldering clothing by applying water or by smothering with a fire blanket or any available clothing.
    - *Do not attempt to remove clothing.* Burnt clothing may be stuck or melted to the affected area.
    - Do not apply ointments, commercial preparations, grease, or other home remedies; those substances may cause further complications and interfere with treatment by the physician.
2. Do not attempt to administer any liquids or medicines orally to unconscious persons.
3. Cover the patient with a blanket.
4. If the hands are involved, keep them above the level of the heart.
5. Keep burned feet or legs elevated. (The victim should not be allowed to walk.)
6. Slightly elevate the head of a victim with facial burns. Keep the person under continuous observation for breathing difficulty. If respiratory problems develop, an open airway must be maintained.

7. Avoid immersing an extensively burned area or applying ice water over it; the cold may intensify the shock reaction. Cool water may be applied to the burned area to relieve pain and stop any further burning. Follow with the application of a dry, clean dressing or sheet.
8. Obtain medical assistance immediately by following the serious injury or illness routine provided for in emergency procedures.

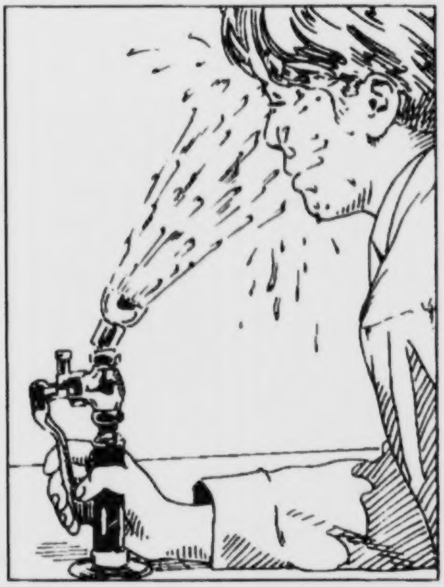
Use of a Fire Blanket

If a student's clothing catches fire, the student should not run. He or she should stop, drop, and roll on the ground immediately while another student brings the fire blanket. Then the burn victim should roll up in the blanket to smother the flames. The blanket should be held close at the neck to force the flames away from the head and hair while the student is rolling up in the blanket. Water, if available, may be appropriately used with the fire blanket to extinguish the flames.

Do *not* use a fire extinguisher on a person because serious chemical reactions or frostbite (with the use of a CO_2 extinguisher) may result from such use.

D Eye Injuries

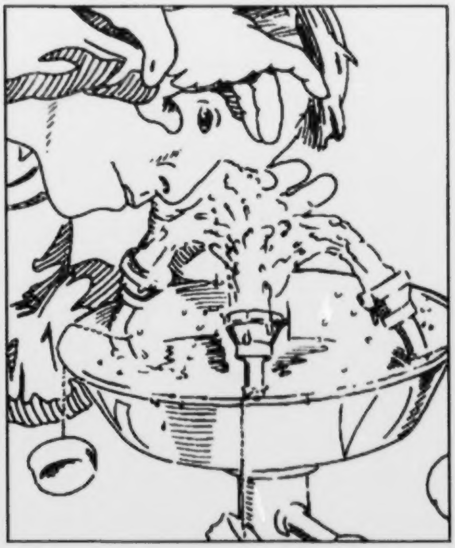
Immediate first-aid treatment for eye injuries may save the eyesight of an injured student. It is important to identify the source of chemical injuries to the eye.



Exposure of the Eye to Chemicals—Acid Burns

Begin first aid for acid burns of the eye as quickly as possible.

1. Thoroughly wash the face, eyelid, and eye with tap water for at least 15 minutes, using the eyewash or eye/facewash station if possible (see Chapter 7, section D, "Eyewash Station"). If the victim is lying down, turn the head to the side; gently hold the eyelid open and, using the drench hose, apply water from the inner corner of the eye outward. Make sure that the chemical does not wash into the other eye.
2. Cover the eye with a dry, clean protective dressing (do *not* use cotton) and gently bandage in place.
3. Caution the victim against rubbing the eye.
4. Have the victim transported to an ophthalmologist's office or a hospital emergency room for further evaluation and treatment.



Chemical Burns of the Eye—Alkali Burns

Alkali burns of the eye are progressive injuries. An eye that at first appears to have only slight surface injuries may develop deep inflammation and tissue destruction, and the patient may lose eyesight.

1. Flood the eye thoroughly with water for 15 minutes, using the eyewash or eyewash/facewash station. If the victim is lying down, turn the head to the side. Gently hold the eyelid open and, using the drench hose, apply water from the inner corner of the eye outward. Make sure the chemical does not wash into the other eye.

2. Cover the eye with a dry, clean protective dressing (do *not* use cotton) and gently bandage in place.
3. Caution the victim against rubbing the eye.
4. Take the victim to an ophthalmologist's office or an emergency room for further evaluation and treatment.

Other Chemicals in the Eye

1. Hold eyelids open; wash eyes immediately, using the eyewash or eyewash/facewash station, and continue to wash for at least 15 minutes. Make sure that the chemical does not wash into an unaffected eye.
2. Have someone call the poison control center to ascertain the need for further medical treatment. (See Appendix E for a list of poison control centers.)

E Exposure to Poisons

Proper storage and safety precautions, including correct labeling of all containers (see Chapter 5, section F), are effective in preventing poisoning; instructors should follow those procedures. It is important to identify not only the poison but also the mode of entry. The danger of poisoning is present, and the teacher must be ready to act immediately.

Poison control centers are available to assist in evaluating the potential health risks from an exposure and the need for first aid and further medical management. (See Appendix E for a list of poison control centers.)

The poison control center should be given the following information:

- Age of the victim
- Name of the poison involved
- Amount or degree of exposure
- Time of ingestion or exposure
- Condition of the victim
- Any first aid that has been performed

The control center staff will provide detailed instructions about additional steps to be taken.

If at any time the victim loses consciousness or develops difficulty in breathing, dial 911 to summon emergency medical personnel. Rescue breathing and CPR should be performed, if needed.

Inhaled Poisons

1. Carry the victim immediately, if possible (do not let him or her walk), to fresh air. Open all doors and windows if the victim is too heavy to carry.
2. Loosen clothing.
3. Use appropriate mouth-to-nose or mouth-to-mouth rescue breathing or cardiopulmonary resuscitation (CPR) or both if the victim is not breathing. Be sure not to inhale the patient's breath. Do not stop until the patient breathes or help arrives.
4. Have someone else dial 911 on the telephone for emergency medical assistance.
5. See treatment of shock under section G in this chapter.

Ingested Poisons

1. Call the poison control center nearest you (see Appendix E), give the staff the necessary information, and follow the staff's instructions.
2. Be prepared to administer syrup of ipecac to induce vomiting, if required. However, the ipecac should not be administered unless instructions are provided by the poison control center or a physician. Never induce vomiting in a stuporous or unconscious person.
3. Take the victim to a doctor or medical facility for further evaluation and treatment if instructed to do so. Take with you the package or container of the ingested poison, with the intact label(s), as well as any vomited material. Avoid self-contamination.
4. *Note:* If there is any delay in the above procedures, the patient may be allowed to rinse out his or her mouth with water. A *small* quantity of water (2 to 4 ounces [60 to 120 ml]) may be swallowed to relieve any localized irritation in the throat or esophagus. It is *no longer* considered appropriate to give 8 to 16 ounces (240 to 480 ml) to dilute the poison in the stomach, unless a stomach tube is in place and suction (aspiration) is proceeding. Dilution of the poison will sweep the poison out of the stomach (through the pylorus) and beyond the reach of the emergency-room gastric pump.
5. Notify the parents or guardians and arrange for them to meet the child at the hospital.

Poison (Chemicals) on Skin

1. Remove any clothing with chemicals or poison on it and place the clothing in a plastic bag labeled

with the name of the injured person. Avoid self-contamination.
2. Wash the skin with large quantities of cool running water.
3. Call the poison control center to determine the need for additional treatment (see Appendix E).

Poison Oak

Poison oak is common in wooded areas throughout California. The skin rash some people develop when they come in contact with poison oak sap is called allergic contact dermatitis. The first exposure to the sap may cause an allergic tendency; repeated exposure may cause skin cells to become sensitized. It is not necessary to touch the plant to develop a rash; the sap can be carried by clothes, tools, pets, and even by the smoke from the burning plant. However, not everyone develops allergies from these plants, and sensitivity varies among individuals.

Once the skin is sensitized, a rash develops whenever another contact is made with the sap. Initially, the rash is red and itches. Blistering may occur later. If the rash spreads, some sap has remained on the skin (or reexposure has occurred). The serum from existing rashes does not spread the rash.

The treatment for exposure to poison oak is as follows:

1. Wash all exposed surfaces with soap and water.
2. Wash all clothes, shoes, belts, bedding, and animals exposed.
3. *Do not* use calamine lotion over the area.
4. Use wet soaks with tepid water for 20 to 30 minutes every two hours.
5. Use baking soda paste to reduce the itching.
6. See your family physician for diagnosis and suggested management.

Note: For further information about poisonous plants, see Chapter 7, section F, "Poisonous Plants."

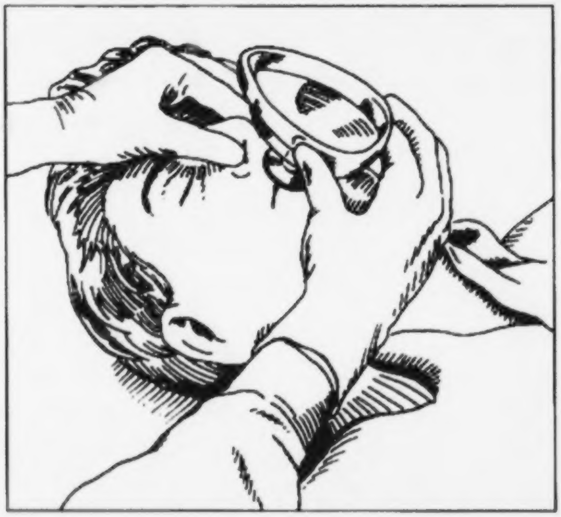
F Cardiopulmonary Resuscitation (CPR)

This procedure must be administered by someone who has been trained according to the standards of the American National Red Cross or the American Heart Association.

Basic life support is an emergency first-aid procedure that consists of the recognition of airway obstruction, respiratory arrest, and cardiac arrest and the proper application of cardiopulmonary resuscitation (CPR).

The CPR procedure consists of:

1. Opening an airway and maintaining the open airway
2. Providing artificial ventilation by means of rescue breathing
3. Providing artificial circulation by means of external heart compression



Each science teacher should be familiar with the CPR procedure because experience has shown that a stoppage of breathing is seldom isolated from a heart stoppage. Even if normal breathing and heartbeat are not restored, the injured person can be kept alive by this procedure until expert medical assistance is available.

Any condition requiring CPR is a serious medical emergency. During the execution of CPR, another staff member or responsible individual should be notifying the parent and having the nurse send for an ambulance and paramedics or the police or sheriff. (See the telephone numbers on page ix in the first tabbed divider section, "School District Emergency and Safety Procedures.") The ambulance/paramedics crew is especially trained for such emergencies, carries hospital emergency-room equipment, and often communicates with hospital emergency staff, receiving instructions as well as providing information so that the emergency-room staff are better able to prepare for the patient's arrival.

G Shock

Shock from injury is also called traumatic shock. Body functions are depressed, and death may result, even though injuries would not otherwise be fatal. Look for the following symptoms:

1. Pale or bluish skin. In a dark-skinned victim, examine mucous membranes inside the mouth or under the eyelids.
2. Moist or clammy skin.
3. Rapid pulse, often too faint to be felt at the wrist.
4. Increased breathing rate; shallow breathing if there is chest or abdominal pain.
5. Weakness. If the weakness is caused by hemorrhage, the victim may also be restless and anxious. The patient will complain of deep thirst.
6. Retching or vomiting. Note the following:
   - If the patient has vomited, save a sample.
   - Do not give fluids; do not induce vomiting.
   - If an unconscious victim is vomiting, logroll the patient onto his or her side to prevent aspiration. During logrolling it is important to stabilize the head and trunk by manual in-line immobilization, especially in patients with trauma or suspected trauma to the head or spinal cord.
7. Fainting or collapse.

Treatment of shock consists of these measures:

- Keep the victim lying down.
- Cover the victim to minimize further loss of body heat.
- Use mouth-to-nose or mouth-to-mouth rescue breathing or CPR or both if the victim stops breathing.

3

GENERAL LABORATORY SAFETY PRECAUTIONS

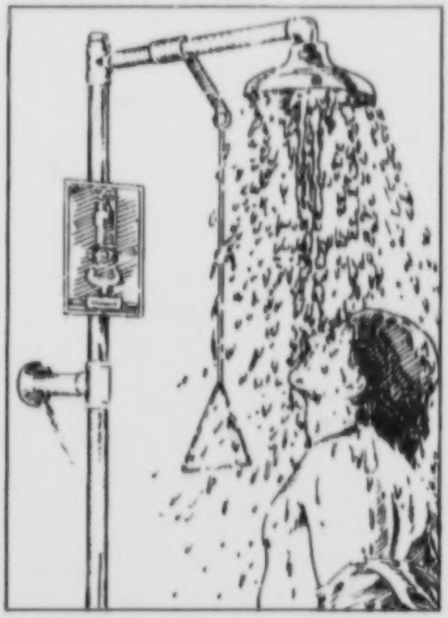
Note: **Procedures discussed in this handbook involve potential dangers to persons, animals, and other living things and, therefore, should be performed only by persons who are technically trained and qualified.**

3. GENERAL LABORATORY SAFETY PRECAUTIONS

THE LABORATORY SCIENCE INSTRUCTIONAL program should be carefully planned and conducted to ensure maximum safety conditions for all personnel. Teachers who have particular concerns about safety conditions related to facilities, equipment, supplies, curriculum, classroom occupant load, and so forth should notify their school-site administrator *in writing* immediately for assistance in relieving the condition.

The following list identifies safety practices and regulations common to all school science laboratories. Additional laboratory and safety practices for specific subject areas and teaching situations are provided in subsequent chapters.

1. Teachers must be fully acquainted with the first-aid procedures, treatment, and regulations provided in Chapter 2 of this publication.
2. Teachers must have a thorough understanding of the potential hazards of all the materials, processes, and equipment that will be used in their school laboratory.
3. Teachers should know the risks involved in using chemicals and should prepare the chemicals before class begins. Neutralizing solutions should be available for dangerous materials used by students.
4. Teachers must report any student injury or accident immediately on their school district's accident report form, available in the main office or health office of each school. (See the sample accident report form included in Appendix D.)
5. Safety in the laboratory should be taught and reinforced throughout the year. The teacher should make notations of each instructional act regarding safety in the daily lesson plans and maintain a record (log) for each class to document the specific topics of safety instruction and the dates on which they were taught. Thorough instruction on necessary safety procedures, including appropriate disposal of excess or waste chemicals, must precede each laboratory activity. (See Appendix F for sample classroom safety regulations and a sample student science safety contract; see Appendix G for a sample science laboratory safety test.)
6. The use of approved eye-protective devices is required of all persons performing science activities involving hazards to the eyes. All persons in dangerous proximity to such laboratory activity (that is, all persons within the laboratory) must also wear approved eye-protective devices. (Read carefully Chapter 7, section C, "Eye Safety," and *Education Code* sections 32030–32033 [found in Appendix B].)
7. A plumbed-in eyewash station, supported by a face-and-shower "drench hose," must be available in each laboratory/classroom in which chemical splashes on eyes, skin, or clothing are possible.



Teachers and students should be familiar with the location and function of the eyewash station. An emergency shower must be provided in work locations in which areas of the body may come in contact with corrosive or severely irritating substances. If the emergency eyewash facility and shower are *both* needed, they must be usable simultaneously by one person. No more than 10 seconds must be required for the injured person to reach the eyewash and shower station when needed. (See Chapter 7, section D, "Eyewash Station," and the *California Code of Regulations, Title 8,* Section 5162 [found in Appendix B].)

8. Science teachers must be aware of the code requirements and other information on eye safety

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discussed in items 6 and 7. Many of the hazardous activities described below are of interest to science teachers in junior high school and teachers of general science courses in grades nine through twelve. The following additional information on eye protection is particularly important to those teachers:

a. There is potential for injury to eyes when working with hot liquids or solids or with chemicals that are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, or radioactive or that generate pressure through heat, decomposition, or other means. Splash-proof goggles and face shields must be worn.

b. Investigations in geology and earth science frequently involve such activities as hammering, chipping, and grinding rocks, minerals, and metals. When hammering or chipping is being done, the use of eye-protective devices, as well as a cloth cover over the rock or mineral to reduce the hazards from flying particles, is absolutely necessary. When grinding rocks, use a face shield for protection.

c. *Students must not look directly into the sun,* even during complete solar eclipses. The danger of retinal burn comes from the invisible infrared rays, which penetrate light filters and instantaneously damage eyes. The retina is not sensitive to pain; therefore, the victim might not immediately be aware of eye damage. Retinal burns are incurable and destroy the field of fine vision. The victim's ability to read can be lost forever.

   Note:

   - No homemade eye protection has been approved for use when the sun is being viewed. Therefore, students may not participate in this activity unless images of the sun can be projected or can be viewed through a commercial telescope with an approved objective filter. Do not use the viewfinder of any telescope during an activity that involves viewing the sun unless the viewfinder is especially designed for that purpose. To avoid eye injury that may result from accidentally tripping the mechanism and engaging the viewfinder, place tape on the bracket supporting the mirror for the finder to hold the bracket in a position to shade the mirror. Teachers must closely supervise all activities in which a telescope is used.
   - Layers of photographic film or welders' masks should not be used to look directly into the sun, even during a complete solar eclipse.
   - The indirect pinhole method should be used to view the eclipse. A projector for observing the eclipse can be made with two pieces of white cardboard. A pinhole or pencil-point hole in the top piece serves to project and focus the image of the eclipse on the second piece. The size of the image can be changed by altering the distance between the two pieces of cardboard.

d. When using infrared and ultraviolet light sources, observers must shield themselves from a direct view of the light source.

9. Reagent and storage bottles containing chemicals should be properly labeled (including date of receipt or preparation) at all times.[5] If the label is lost and the contents are unknown, the substance should be regarded as potentially hazardous and must be chemically categorized by an experienced waste specialist before possible treatment and transport to a proper disposal site.
10. Poisons and dangerous reactants should be made inaccessible to students except during actual usage. Students should be instructed never to taste or place any substance or object in the mouth except as specifically directed by the teacher under controlled conditions.
11. Suction devices or pumps should be used when pipetting, *never the mouth.*
12. Chemicals should be stored according to their compatibility group in a *single* safe and practical storage pattern. Adopt and standardize a plan that is agreeable to all staff members and use it *throughout* the school. The storage compatibility categories shown in Chapter 5, section E, step 7, are suggested for use in all California secondary schools. Use of more than one storage compatibility system at one site could be dangerous.

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[5] Minimum precautionary labeling standards for injurious substances used in places of employment in California are established in *California Code of Regulations, Title 8,* General Industry Safety Orders, Article 112: Labeling of Injurious Substances (sections 5225–5228). The labeling standards that are of special concern to high school science teachers are included in Chapter 5, section F, of this handbook.

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13. Chemicals should not be stored directly on the floor. This precaution will prevent the contact of chemicals with water from flooding, mopping, or condensation and the puddling of liquid contents of defective or broken containers around adjacent stored chemicals. Large containers should be stored on the lowest shelves to minimize the danger of breakage or spillage when containers are being removed or replaced. (See Appendix B for *California Code of Regulations, Title 8,* sections 5163 and 5164.)
14. No explosive chemicals should be kept in the school laboratory. See Chapter 5, Table 1, for examples of common explosive chemicals, which *must be disposed of only by trained and qualified officials.* (Consult Chapter 5, section E, step 2, for more information.)
15. Any known carcinogen must be removed from the science area and disposed of appropriately. (See Chapter 5, Table 2, "Extremely Hazardous Chemicals for Prompt Disposal.")

    Note: Products made of asbestos, once used in the manufacture of heating pads, wire gauze centers, beaker tongs, gloves, and various other products, must be replaced by ceramic-fiber or glass-fiber products unless the asbestos fibers are permanently bonded in a hard sheet, such as in the commonly used building material.
16. Food for human consumption should not be stored in refrigerators or cabinets or on shelves used for storing chemicals or biological materials. Food should *not* be eaten in science laboratories or storage areas because of the danger of ingesting toxic or corrosive substances.
17. In an experiment or demonstration involving any flammable liquid (such as alcohol), care must be taken that any flame in the room is at an absolutely safe distance from the volatile liquid. Vapors may flow along a table or countertop for long distances to an unseen ignition source, then blast back. Beware of gas water heaters in or near science classrooms or stockrooms.
18. Teachers and students should be familiar with the operation of all fire extinguishers in the laboratory. The labels on the extinguishers contain directions for their use.
19. Teachers should be familiar with the location of all master controls for utilities, especially the master valve in each room for the gas outlets. Mark or color-code all services clearly.
20. The instructional area should be kept free of spills, broken glass, and unnecessary equipment and materials. Good housekeeping is essential.
21. Stone crocks or plastic containers should be provided for the disposal of dangerous waste chemicals and solid materials. Three different waste receptacles should be provided for (1) broken glass; (2) spent matches; and (3) wastepaper. Arrangements should be made for further disposal of the waste chemicals, in accordance with the Solid Waste Disposal Act, at an appropriate disposal site for hazardous materials. (See Chapter 5, section E, step 6.)
22. Teachers should avoid unsafe practices by instructing and cautioning students about the correct techniques for the following activities:
    - Using a Bunsen burner and other related flame-producing equipment
    - Heating liquids in test tubes, beakers, and crucibles
    - Handling reagent bottles
    - Using polyethylene squeeze bottles
    - Obtaining and handling dry chemicals
    - Filtering
    - Cutting, bending, and fire-polishing glass tubing and rods
    - Using other laboratory materials, as appropriate; for example, pipettes
23. When an electrical plug is to be removed from its socket, the plug, not the electrical cord, should be pulled.
24. Laboratories should always be locked when not in use.
25. The custodial staff should be alerted to general hazards they may encounter in science areas and to special situations that arise.
26. Teachers should set an example for the students; for example, wear goggles when students are required to do so. Follow all safety regulations and constantly be alert and remind students of hazards. Students not adhering to your rules should not be allowed to participate until you are assured there will be no further infractions.
27. Periodic use should be made of the "Safety Checklist for Science Instruction, Preparation, and Storage Areas" to check classroom and preparation areas (see Appendix H). Safety and energy-savings procedures should be carried out at the end of each school year (see Appendix I).

4

SAFETY IN THE BIOLOGY LABORATORY

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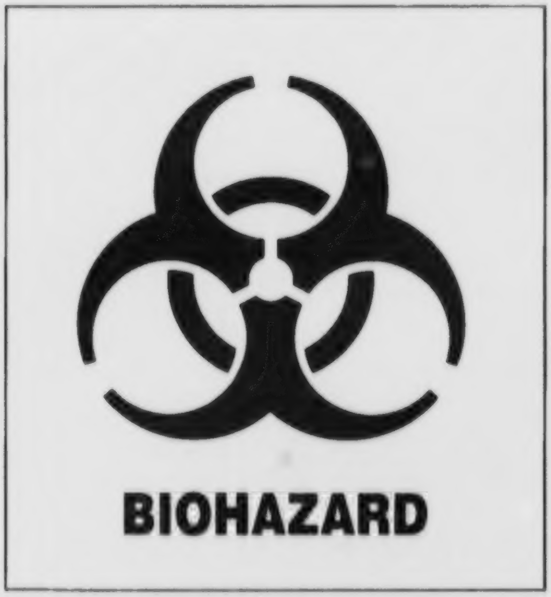
***Note:* Procedures discussed in this handbook involve potential dangers to persons, animals, and other living things and, therefore, should be performed only by persons who are technically trained and qualified.**

4. Safety in the Biology Laboratory

BIOLOGY AND PHYSIOLOGY TEACHERS SHOULD BE familiar with the following safety practices and all other sections of the handbook pertinent to their instructional program. Special attention is directed to Appendix J, "Sample Biological Science Laboratory Regulations." General precautions are as follows:

- When experiments require special biological substances, such as nicotine alkaloid, the materials should be carefully supervised.
- The use of drugs and syringe needles must be limited to those uses specifically called for in the instructional program and to specific projects under close supervision of the instructor. Keep all drugs and syringe equipment in a safe, locked place.
- Radioactive materials used in biological research should be properly marked and, when not in use, appropriately secured.



- Volatile solvents, such as acetone used in paper chromatography experiments, should be used only in an area that is well ventilated or, if available, in a fume hood.
- All laws and regulations regarding the use of animals in science instruction should be adhered to.

A Human Blood Sampling

1. The *California Code of Regulations, Title 8,* General Industry Safety Orders, Section 5193, essentially requires each school district in the state to prepare a written exposure control plan (ECP) designed to eliminate or minimize the exposure of all employees to the blood or certain body fluids of any other person, thus eliminating or minimizing the likelihood of employees being infected by bloodborne pathogens (see Chapter 7, section K; and Appendix B). A similar responsibility to protect students from such infection is implied.

   Options to using fresh human blood, though less desirable instructionally, are possible. It may be possible to acquire, from a local blood bank, blood (types A, B, O, and AB) that has been tested and found free of the hepatitis B virus and the human immunodeficiency virus (HIV). The blood may be used either in a teacher demonstration (using the overhead projector) of the common blood types or in a student laboratory activity. Such use should be performed with all the precautions of the school district's ECP because testing for the pathogens noted above is imperfect.

   If blood typing or other microscopic analysis of fresh human blood is *permitted* by the school district and is to be conducted in the classroom, the blood sampling must be done pursuant to the district's ECP. In the absence of more specific procedures, the blood sampling should be accomplished as follows:

   - On a voluntary basis
   - Only by those student volunteers who bring a permission note signed by a parent
   - Performed by the volunteer, from herself or himself
   - In a manner consistent with the school's exposure control plan

2. Several days before providing the opportunity for voluntary blood sampling by students, discuss with the students the techniques they will learn. Emphasize that for most students this is a perfectly safe procedure (except for possible infec-

tion from someone else's blood); discuss the risks for hemophiliacs and others. Emphasize also that the results of the tests are not to be considered valid for diagnostic purposes.

Explain to the class that students must *not* participate in the blood sampling if they have any known medical problem, especially any of the following conditions:

- Diabetes.
- Excessive bleeding (characteristic of hemophiliacs and users of prescribed drugs that lengthen clotting time, such as Coumadin, or drugs prescribed for a heart condition).
- Hepatitis (during the preceding year). If hepatitis B or C is involved, a student may still be a carrier and could infect other students from contact with blood on table tops, broken lancets, and so forth.
- Chronic pyoderma (skin pus areas, recurring boils). Students with this condition would likely have skin contaminated with staphylococcus and streptococcus bacteria. Puncturing of such contaminated skin could produce a new infection site. If the lancet were accidentally reused, it could transmit the bacteria to other students.
- Infection with HIV. The blood can transmit the virus from an infected person to another person if the virus gains entrance into the blood of that other person.

Students with any such medical problems do not need to tell the teacher or their classmates; they simply would not bring to school a note of permission from their parents. Thus they need not be embarrassed about or reveal their medical problem.

The majority of students who carry hepatitis B or C or HIV are not aware that they are infected. For this reason teachers and students should follow the universal safety precautions outlined by the school district's ECP (see Appendix B, *California Code of Regulations, Title 8,* General Industry Safety Orders, Section 5193, Bloodborne Pathogens).

3. The danger of spreading infectious diseases, such as hepatitis or HIV, makes it necessary to employ only sterile techniques, including the use of goggles and gloves, if feasible.
4. Blood should be drawn only by use of a new, individually packaged sterile lancet. Lancets are to be used *one time only,* then discarded promptly in a container designated for that purpose by the school district's ECP.
5. The use of disposable lancets meets the requirements for this activity. Each lancet should be used only once, by and for one person. The unbroken lancet should be discarded in the container designated for that purpose.
6. If several students in one class period wish voluntarily to draw blood samples for use by themselves, each student drawing a sample must have a separate sterile lancet, which is to be used to make only *one* puncture.
7. The surface of the finger from which the blood is to be drawn must be rubbed with sterile absorbent cotton dipped in alcohol before puncturing the skin. Use a fresh piece of sterile cotton after removing blood to stop the bleeding.
8. After examining the samples, standard sterilization and disinfection procedures must be used. Glassware, devices, or instruments that require sterilization or disinfection should first be immersed in a solution at least (no weaker than) one part bleach to 10 parts water (1:10), then thoroughly cleaned before being exposed to a germicide; the manufacturer's instruction for use of the germicide should be followed.
9. The cotton swabs should be processed as regulated waste for either (a) vendor pickup, by placing the waste in individual red bags prepared according to the vendor's instructions; or (b) disposal, if an outside vendor is not used, by placing the waste in containers that are:
    - Closable
    - Constructed to contain all contents and prevent leakage of fluids during handling, storage, transport, or shipping
    - Appropriately labeled and color-coded
    - Closed prior to removal to prevent spillage or protrusion of contents during handling, storage, transport, or shipping
10. The entire activity area should be wiped down with a 1:10 bleach solution following the experiment.
11. As usual, washing hands with soap and water after the laboratory activity is mandatory.

B Epithelial Tissue Study

1. Students should exercise great care in obtaining epithelial cells from the inside of the cheek for study under the microscope. Only a cotton-tipped swab or the blunt edge of a toothpick should be used. *Never* use pointed instruments or any part of a scalpel for this purpose.
2. Only student volunteers who bring a permission note signed by a parent would conduct this experiment.
3. Precautions and cleanup procedures similar to those used in blood sampling should be followed.

C Use of Microscopes and Hand Lenses

When students have eye infections, they should not be permitted to use school microscopes or hand lenses.

D Experiments with Bacteria and Fungi

1. All bacteria and fungi should be handled as though they were pathogens. Pathogenic bacteria should *not* be cultured. Pure cultures of nonpathogenic microorganisms should be used in experiments. When soil or water is used as a source of bacteria (or fungi), it is important to collect samples unlikely to be contaminated by human pathogens. For example, water should be collected from lakes, estuaries, or beaches free of sewage or animal-waste pollution. (See section E for special concerns in studying air and soil cultures of fungi and molds.)
2. Petri dishes passed around the classroom for inspection of cultures should be bound together with transparent tape. Any petri dish that contains fungus should be taped shut.
3. Wire loops used for transferring bacteria cultures should be flamed until the *entire* wire is *red* hot before and after each transfer is made.
4. Inoculating loops must be used with care. The film held by a loop may break and cause substantial atmospheric contamination. A hot loop inserted into a liquid may cause spattering. Loops should be allowed to cool before insertion into liquids. The procedure may require the use of more than one loop so that as one is being used, others are cooling. When a contaminated loop is inserted into a flame for sterilization, an aerosol may be generated by the boiling and volatilization of the material before the flame can kill all pathogenic microorganisms. Whenever inoculating loops are being used, avoid any sudden actions that might result in the generation of an aerosol.

   These precautions are intended for laboratory activities involving any bacteria or fungi. Even nonpathogenic microorganisms can cause disease if they enter the body accidentally. This danger is especially true if the human system is immunosuppressed because of HIV, intake of drugs, and so forth.

5. To sterilize plates before cleaning or disposal, follow these steps:
   a. Autoclave the unopened plates in the usual manner. Usually, steaming under pressure of 15 pounds per square inch for 15 to 20 minutes kills the majority of microbes. However, if you are trying to sterilize soil samples or large volumes of culture, continue with the procedure described below.
   b. Wait one day for any resistant spores to leave the resting stage and begin to grow.
   c. Sterilize a second time.
   d. Wait one day.
   e. Sterilize a third time.
   f. *Note:* All resistant spores should by now be killed. The plate may be safely opened for cleaning or discarded in the regular trash.

E Special Concerns in the Study of Fungi and Molds

Whenever agar plates are inoculated with soil or plant material or exposed to the air inside or outside a building, there is the strong possibility that fungi (molds) will grow on the surface of the plates and form aerial hyphae. At the tips of these hyphae, chains of conidia (spores) will form; the conidia are often colored. These conidia are easily dislodged by air currents and can be rapidly spread through a room when the lid of the petri dish is removed. People with normal immune systems are usually not infected when they breathe in these spores. However, people with weakened or suppressed immune systems are at risk of developing a fungal infection should they inhale the spores. Immune systems can be damaged by immunosuppressant drugs, HIV infections, or other causes. Therefore, it is good practice, once the petri dishes are inoculated, to *tape* the lids on with two pieces of tape opposite each other and allow manipulations of the fungal growth only in a fume hood in which a current of air draws the spores out of the room.

Fungi are microorganisms that are widespread in soil, dust, and air. Of particular concern is the fungus *Coccidioides immitis*, which is present in some soils of the southwestern United States. Most people, on inhalation of the spores, develop a mild flu-like respiratory illness called valley fever, which quickly passes. Usually, people acquire a lifelong immunity to reinfection. Some unfortunate people become very ill and may die, even with medical care. Therefore, it is essential for students working with soil, or the fungi in soil, to be aware of this hazard and not expose themselves to large amounts of the dust or spores. In areas endemic to valley fever, you should restrict the collection of soil to sites within five miles of the Pacific Ocean (in the United States) to minimize exposure to spores of the fungus that causes that disease. Soil contaminated with old chicken, pigeon, or bat droppings may contain the spores of the fungus that causes histoplasmosis. Soil from archeological sites, the land around old buildings, and animal burrows should be avoided, regardless of the location.

F Operation of Pressure Cooker for Sterilization

1. Before using the pressure cooker, the teacher should be familiar with the proper directions for its operation.
2. The safety valve should be examined to make sure it is in working order.
3. The gauge pressure should be kept at or below a maximum of 20 pounds per square inch.
4. The pressure should be returned to zero before the cover can be safely removed.
5. The test stopcock should be opened before the clamp can be safely released.
6. An eye-protective device should be used when working with a cooker under pressure.

G Extraction of Chlorophyll, Using Flammable Solvents

1. An electric heater of the immersion type or a water bath heated by an electric hot plate should be used.
2. An open-flame-heated water bath for heating the alcohol or other solvents should *never* be used.
3. Flames should be kept away from solvents or vapors. If a solvent ignites in the beaker, cover the beaker with a glass plate to extinguish the fire. If burning solvent is spilled on the table, use either the carbon dioxide (or 2A-10BC dry powder) fog extinguisher or the fire blanket. These devices should be kept readily available.

H Risks in Use of Acrylamide

In recent years polyacrylamide gels have been prepared in some school laboratories to achieve the isolation of specific molecules by electrophoretic techniques. Schools are cautioned to cease this practice because acrylamide poses a potentially serious health hazard as a neurotoxin. This substance has been classified as 2B (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC) and is included in the California Health and Welfare Agency's list titled "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity" (*California Code of Regulations, Title 22,* Section 12000).

Because there is a serious risk of inhalation exposure during the weighing of acrylamide powder for the preparation of gels, schools should purchase only prepoured polyacrylamide gels from laboratory supply houses. The prepoured gel presents less health risk because the acrylamide has chemically reacted to form a solid gel (letter from the California Department of Health Services, July 10, 1992). Once the gel has solidified and been rinsed, very little of the raw acrylamide remains. Gloves should be worn at all times to prevent dermal exposure to any residual acrylamide found on the gels. To avoid the hazard altogether, schools can purchase prepoured gels made with acrylamide substitutes.

Questions about the proper disposal of polyacrylamide gels should be directed to your regional office of the Department of Toxic Substances Control (see Appendix K).

I Risks in Use of Ethidium Bromide

Used as a staining agent for gel plates in recombinant DNA protocols, ethidium bromide has been tested extensively and has been shown to be a potent mutagen. Although ethidium bromide has not yet been tested for carcinogenicity, scientists believe that chemicals that can cause mutations (by altering DNA) should be treated as though they have carcinogenic potential as well. Therefore, great care must be used when handling ethidium bromide.

The highest potential for either respiratory or dermal exposure is during the weighing and preparation of stock solutions. In addition, splashing in the eye or on the skin can occur during the dyeing of gels. Because ethidium bromide presents high risks for anyone, its use should be limited to instructors only. Note that industrial hygienists at the California Department of Health Services recommend that *ethidium bromide not be used in the high school laboratory.* However, when its use cannot be avoided, the Department of Health Services recommends the following handling practices:

1. Ethidium bromide powder and stock solutions should be kept in a locked cabinet.
2. Ethidium bromide powder and ethidium bromide solutions should be handled only by the instructor. Preparation of stock solutions and the dyeing and rinsing of gels should be done only by the instructor. The instructor should use the least concentrated dye solution which still stains effectively.
3. Ethidium bromide powder should be dispensed only in a laboratory that is not subject to drafts created by doors, windows, and laboratory cross traffic. Transfer of the powder should be done within a fume hood over a disposable working surface or over a tray that can be decontaminated if spillage occurs. To minimize contact with ethidium bromide, the instructor should weigh portions in advance, when possible, and store them for future use.
4. To prevent skin contamination and subsequent dermal absorption or hand-to-mouth exposure, the instructor should wear tight-fitting, disposable, impermeable gloves. Common surgical latex gloves may offer some protection. A laboratory jacket or apron should also be worn.
5. Students should not handle dyed gels until the gels have been rinsed thoroughly. Once the dye is fixed and the excess rinsed off, there will be little free ethidium bromide. However, students should still wear latex gloves and handle the gels with care. Goggles should be worn whenever exposure is likely to occur.
6. Ethidium bromide powder and solutions, dyed gels, and disposable materials contaminated with ethidium bromide should be disposed of according to applicable hazardous waste disposal regulations.

The most effective way to control exposure to ethidium bromide is to replace it with a less hazardous substance. However, all substitutes must be carefully researched to ensure that they are truly less hazardous. Two substances, propidium diiodide and acridine orange, have been suggested as replacements for ethidium bromide but have also been found to be mutagens; therefore, they are likely to be just as dangerous. Bromophenol blue and methylene blue are less hazardous substitutes to consider for use in staining. But because stains are specific to particular molecules, these substances may not be adequate to stain all types of samples.

J Risks in Use of Formaldehyde

Because of growing evidence on the carcinogenicity of formaldehyde, *schools are urged to cease their use of formaldehyde and formalin* (3 percent to 10 percent solutions of formaldehyde) and to arrange for the immediate proper removal and disposal of all formaldehyde cylinders and formalin solutions. The National Toxicology Program (NTP) has rated formaldehyde as an anticipated carcinogen, which means that there is either "limited evidence" of its carcinogenicity in humans or "sufficient evidence" of its carcinogenicity in experimental animals. In addition, the IARC has categorized formaldehyde in group 2A, which means that this agent is "probably carcinogenic to humans" because "there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals." In a list entitled "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity," the California Health and Welfare Agency identifies formaldehyde as a substance known to cause cancer (*California Code of Regulations, Title 22,* Section 12000). If formaldehyde is used at the work site, the employer is mandated by the California *Labor*

Code (Section 9020) and the *California Code of Regulations, Title 8,* to submit a "Carcinogen 'Report of Use' Form" (see Appendix O) and to post a copy of the report form in a conspicuous place in the area in which formaldehyde is used.

Many dissection specimens are originally (commercially) preserved in formalin, then washed and transferred to a less hazardous medium; however, this practice has markedly diminished in recent years. All such specimens should be soaked in water for 24 hours prior to use and, occasionally, during use, when residual formalin is released from the specimen. The contaminated rinse water may not be poured down the sink unless you have obtained permission from your local sewage district authority.

Schools are advised to use a properly licensed waste transporter to dispose of all preserved display specimens immersed in formalin. In the rare case that the specimen is irreplaceable, it should be properly transferred to a less hazardous solution (e.g., propylene glycol, ethylene glycol, or ethanol). For dissections of organisms preserved in this manner, adequate ventilation is still necessary. All transfers of specimens from formalin should take place within an operating fume hood and proper personal protective equipment should be worn to avoid respiratory and dermal exposure. The remaining formalin *may not* be poured down the sink unless written permission has been obtained from the local sewage district or administrative agency.

If there is a formaldehyde spill, all personnel should be promptly evacuated from the immediate area and the room should be thoroughly ventilated. Cleanup should be attempted only by properly equipped and trained spill-control specialists.

Regulations in the General Industry Safety Orders (*California Code of Regulations, Title 8,* Section 5217) establish specific requirements for the monitoring and safety training of employees exposed to airborne formaldehyde at or above each of the following levels:

1. The action level of 0.5 parts formaldehyde per million parts air (ppm), an eight-hour time-weighted average concentration. Action level is determined by measuring the concentration of a chemical substance, calculated as an eight-hour time-weighted average.
2. The permissible exposure level (PEL) of 0.75 ppm formaldehyde, an eight-hour time-weighted average concentration. PEL is defined as "the maximum permitted eight-hour time-weighted average concentration of an airborne contaminant" that an employee can be exposed to in one day.
3. The short-term exposure level (STEL) of 2.0 ppm formaldehyde, which is expressed as a 15-minute time-weighted average concentration. The STEL is not to be exceeded at any time during a workday.

K Instruments and Specimens Used in Dissection

1. The use of preserved animal specimens in instruction should be carefully planned to provide learning that cannot otherwise be achieved. Dissection activities should enable students to develop a greater respect for life. *All* such activities, particularly those involving the use of vertebrates (especially mammals), should be undertaken by students only when they are prepared and have the maturity to appreciate fully the significance of the instructional activity.
2. Students should be instructed in the safe use of dissection instruments. Special care should be taken to avoid cuts or scratches when cleaning scalpels and needles.
3. Specimens should be obtained which, if originally preserved in formalin, have been shipped in alternative, low-toxicity preservatives (see section J, "Risks in Use of Formaldehyde").
4. Preserved specimens should be thoroughly washed (including the abdominal cavities of large specimens) before being handled by the students. When specimens are being removed from the preservative solution, rubber gloves should be worn or forceps or tongs should be used, depending on the size of the specimen. Use eye-protective devices to protect against splashes and fumes.
5. Preservative fumes may be irritating to the eyes, nose, and throat. Adequate ventilation should be provided whenever preservative fumes are present.
6. Approved goggles must be worn during dissections.
7. Preferably, dissection would be carried out only by those students who have obtained a permission note signed by a parent.

Teachers will find the following publications helpful in planning and conducting their dissection activities:

Planning and Managing Dissection Laboratories. Arlington, Va.: National Science Teachers Association, 1994.

The Responsible Use of Animals in Biology Classrooms, Including Alternatives to Dissection. Reston, Va.: National Association of Biology Teachers, 1990.

L Alternatives to Dissection

Students in kindergarten through grade twelve have the right to refrain from participating in activities that they feel would constitute "harmful and destructive use of animals," pursuant to *Education Code* Section 32255 et seq. When courses require the use of live or dead animals or parts of animals, students must be notified of their rights. A student's objections must be substantiated by a note from his or her parent or guardian. The teacher may develop an alternative educational project of "comparable time and effort" or excuse the student from the project.

The pre- and postdissection activities *may* constitute appropriate assignments, which could be pursued in greater depth as alternative activities for all students. Alternative activities should be well planned (not punitive) and may include (1) studies of anatomy, using illustrated dissection manuals, study sheets, transparencies, videos, slides, films, or filmstrips; (2) computer simulations; (3) observations of live organisms; (4) library research; and (5) art activities, with models or charts.

Both of the publications recommended in section K suggest alternatives to dissections; the one available from the National Association of Biology Teachers contains a comprehensive list of resources and literature on the topic. The Animal Protection Institute of Sacramento (1-800-348-7387) and the Humane Education Network of Menlo Park (415-854-8921) are included among the organizations promoting alternatives to animal experimentation in schools. Copies or lists of alternative materials (including costs, as appropriate) may be obtained by calling the telephone numbers noted above.

M Handling of Laboratory Animals

See Appendix B, *Health and Safety Code* Section 1650 et seq., "Humane Care of Animals." In addition, the following precautions should be observed:

1. Heavy rubber or leather gloves should be worn when handling live animals. (Be sure the gloves are readily available.)
2. Students and visitors should be cautioned about the dangers of inserting fingers into an occupied animal cage.
3. Warning signs, such as *Keep hands away,* should be posted conspicuously on cages housing animals that may bite.
4. Students should be trained to handle rats, mice, guinea pigs, and other animals gently and not to excite the animals; for example, poking pencils at animals encourages biting behaviors. Hamsters are not recommended for classroom use because they are nocturnal and are more likely to bite during daylight hours.
5. Poisonous animals should *not* be brought to or kept at school.

N Insect-Killing Jars

Students need to be familiar with the best ways in which to collect and preserve insects for science projects or for study in the classroom. A safe killing jar can be made by using any clean, large jar with a screw-type lid (mayonnaise jars are acceptable). Place a facial tissue in the bottom of the jar to absorb the killing liquid. Several liquids can be used to provide the lethal fumes, including ethyl acetate or ethyl alcohol. (Under no conditions should carbon tetrachloride or potassium cyanide be used in insect-killing jars.) Add the killing liquid to the tissue in the bottom of the jar—about six drops are generally satisfactory. Place a clean tissue on top of the tissue containing the liquid to keep the insects dry. The jar must be labeled properly and include the following information:

DANGER. FLAMMABLE. POISONOUS
FUMES. DO NOT BREATHE.

To recharge the jar with lethal fumes, simply remove the top tissue and add a few more drops of the killing liquid. Add a clean tissue, and the jar is again ready for use.

An alternate method of preparing insect-killing jars is as follows:

1. Place 1 inch (2 to 3 cm) of freshly prepared plaster of paris in the bottom of a glass jar (the smallest size necessary).
2. Pour in enough ethyl acetate to cover the plaster of paris at least 12 hours before use.
3. Let stand for 20 minutes; then pour off the excess. Enough ethyl acetate will be absorbed by the plaster of paris to last a week if covers are kept in place.
4. Use a facial tissue to cover the plaster of paris during use.
5. Label the jar with the information noted above.

5

SAFETY IN THE CHEMISTRY LABORATORY

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***Note:* Procedures discussed in this handbook involve potential dangers to persons, animals, and other living things and, therefore, should be performed only by persons who are technically trained and qualified.**

5. SAFETY IN THE CHEMISTRY LABORATORY

Several recent legislative acts address the use and storage of hazardous chemicals. The *California Code of Regulations, Title 8,* Section 5191, addresses a broad range of requirements for *employers* engaged in the laboratory use of hazardous chemicals (see Appendix B). This regulation requires employers to develop and implement a written chemical hygiene plan (CHP) that sets forth specific procedures for minimizing employees' exposure to hazardous chemicals. For assistance in preparing a CHP, contact your county Environmental Health Department or obtain a copy of the *Model Chemical Hygiene Plan for Kentucky School Districts* (see ordering information in Chapter 7, section J).

Under the regulation school districts are required to designate a qualified chemical hygiene officer to provide technical guidance in the development and implementation of a CHP that ensures that employees' exposure to hazardous chemicals does not exceed Cal/OSHA standards. The CHP must include the following elements: (1) safe operating procedures to be followed when the laboratory work involves hazardous chemicals; (2) criteria for determining and implementing control measures, including engineering controls, the use of personal protective equipment, and hygiene practices; (3) maintenance of proper labels on hazardous substances and of MSDSs received from the vendor; (4) assurance that fume hoods comply with regulations and that all protective equipment functions properly; (5) provisions for employee information and training; (6) provisions for medical consultations and examinations; and (7) recordkeeping.

Related requirements are included in *Education Code* Section 49340 et seq. and the *California Code of Regulations, Title 8,* Section 5194 (see Appendix B). However, a school in full compliance with Section 5191, which is outlined above, will also be in compliance with these code sections if a safe and practical chemicals storage plan is implemented, such as the plan suggested in section E of this chapter.

Chemistry teachers should be familiar with the safety practices described in this chapter and with all other sections of this handbook pertinent to their instructional program. Special attention is directed to Chapter 3, "General Laboratory Safety Precautions"; Appendix H, "Safety Checklist for Science Instruction, Preparation, and Storage Areas"; and Appendix L, "Science Laboratory Safety/Liability Checklist." Additional useful information can be found in the California Department of Education publication titled *Science Facilities Design for California Public Schools* (especially pages 23–27 and 42–46; Chapter VIII; and appendixes B and C).

A Laboratory Practices

1. Care must be taken to give proper instructions and to caution students on the use of polyethylene squeeze bottles and the risk of dropping bottles, especially if the bottles contain flammable liquids. In those cases bottles should not be used near open flames.
2. On inserting glass tubing into a rubber stopper or tubing, observe the following precautions:
    - Never attempt to insert glass tubing that has a jagged edge. Fire-polish the edge, if possible. Otherwise, bevel the edge with a file, wire gauze, or emery cloth.
    - Always aim the glass tubing away from the palm of the hand that holds the stopper or rubber tubing.
    - Use water, soap solution, glycerin, or petroleum jelly as a lubricant and gently press the tube into the hole with a twisting motion.
    - Expand the rubber stopper by using an appropriate size cork borer prior to insertion. Lubrication is still necessary.
    - Always hold glass tubing as close as possible to the part that is entering the rubber stopper.
    - Lessen the chance of injury from broken tubing by wrapping a cloth around the hand or around the tubing at the point of contact with the hand.
    - Do not grasp a thistle tube by the bowl when inserting the thistle tube into a rubber stopper. Grasp only by the tubing, as close as possible to where the glass tubing enters the stopper.
3. Exercise care so that any hose connections between burners and gas outlets are protected from pinching or from being pulled away from the outlet.

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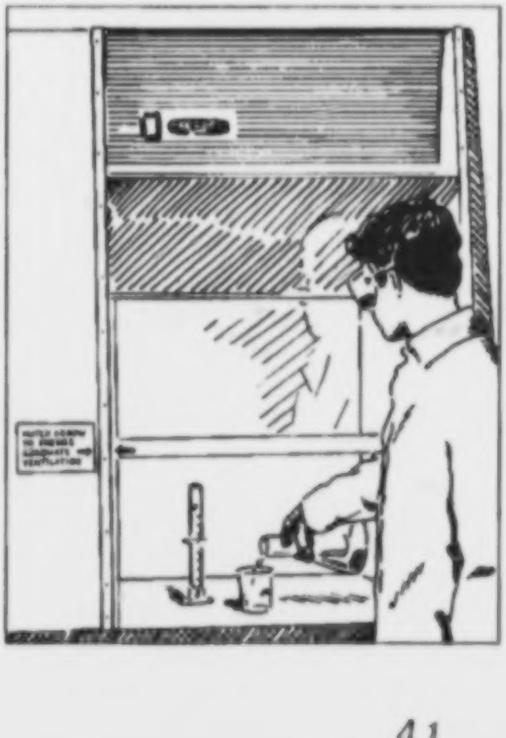
4. Use the stationary or portable fume hood when potentially hazardous vapors or gaseous substances are used or produced in science laboratory activities. Whether permanent or portable, fume hoods must:
    - Have an average face velocity of 100 linear feet (30 m) of air per minute, with a minimum of 70 linear feet (21 m) per minute at any velometer position.
    - Be placed so that air currents do not draw fumes from hoods into the room.
    - Be provided with a means (such as a light plastic or paper streamer) for continuously indicating that air is flowing into the exhaust system during the operation of the fume hood.
    - Be provided with a standpipe that extends seven feet (2.1 m) above the roof and is located so that fumes will not be drawn into windows or air intakes.
    - Have standpipes constructed of corrosion-resistant materials. Local fire codes must be checked for standpipe specifications.

    Fume hoods are never to be used for storage of books, supplies, or chemicals; they are items of safety equipment. Air velocity should be checked with a velometer or a single piece of tissue paper, which should remain horizontal when held in the opening while the hood is operating. (See Appendix B, *California Code of Regulations, Title 8,* Section 5154.1.)



5. Use the stationary or portable fume hood whenever noxious or poisonous fumes are produced.
6. Preserve dry ice for short periods of time by wrapping the ice in several layers of newspaper to insulate it and reduce the rate of sublimation. The use of vermiculite, Styrofoam beads, or other particulate insulating material and a Styrofoam chest will further extend the preservation of dry ice. Dry ice should be handled with great care to avoid contact with the skin and eyes.
7. Handle glass wool and steel wool carefully to avoid getting splinters in the skin or eyes.

B Students' Safety Precautions

1. Students in the proximity of the experiment should wear goggles. Evacuate students from seats near the demonstration table, even if the possibility of injury is remote. Injury might occur from the spattering of chemicals, inhalation of fumes, and so forth.
2. Familiarize the students with the potential hazards of the chemical substances included in Table 3, "Hazardous Chemicals Reference Table."
3. Instruct the students to smell the contents of a test tube or other container by waving some of the escaping vapors toward themselves. The container should never be brought close to the nose.
4. Never cap a bottle or use a solid stopper in a bottle containing dry ice or cryogenic liquids. Always plug loosely with cotton or use a stopper with a hole.
5. Remind students that chemicals should never be tasted, smelled, or touched unless such action is approved by the instructor and conducted in the proper manner.

C Teachers' General Safety Precautions

1. Demonstrations involving potentially toxic or explosive substances must be arranged to protect both students and teachers from danger. The teacher and students should use goggles, face

shields, and safety shields for protection. The size of apparatus and quantities of reagents used in demonstrations should be consistent with safety; for example, whenever potentially hazardous products, such as H_2, Cl_2, Br_2, I_2, P_4O_{10}, and CO, may be generated.

2. Water should never be added to concentrated acids. To dilute acids, add the concentrated acid in small quantities to the water, stirring constantly. Use heat-resistant glassware for this procedure.
3. Table tops should be protected from extreme heat by using insulation under burners or heated objects. Do not use asbestos insulation unless fibers are bonded in a hard material, such as in the frequently used building boards. Broken or chipped boards should be discarded.
4. Only small quantities of red amorphous phosphorus should be made available for students' use. When phosphorus burns, it produces toxic phosphorus pentoxide. Red phosphorus fires are very difficult to extinguish. Red phosphorus resublimes as white phosphorus. White phosphorus may ignite on contact with air at 30°C and should be disposed of by following the guidelines in section E, step 2.
5. After receiving approval from your local air quality regulatory agency, completely burn residues of (red) phosphorus in the fume hood before depositing them in the waste jar.
6. Each science teacher should be prepared to act deliberately and intelligently in the event of a classroom fire.
7. Approved eye-protective devices should be used by all persons performing science activities involving hazards to the eyes. All persons in dangerous proximity must be similarly equipped. Laboratory aprons and rubber or plastic gloves should be available and should be worn whenever hazards exist that could damage clothing, injure someone, or irritate skin.
8. The safety of students while they are participating in field experiences should be considered an integral part of the instructional planning activities.
9. Science teachers must be familiar with state, local, and school district regulations on the use of equipment and materials that produce X rays, microwaves, and alpha, beta, and gamma radiation.

D Chemical Health Hazards

Chemical substances can enter the body and, consequently, the bloodstream in three ways—through ingestion, absorption, or inhalation.

The following list gives examples of some classes of chemical substances and their effects on the body:

Acids: Acetic, chromic, hydrochloric, nitric, sulfuric, and carbolic (phenolic) acids cause severe burns and tissue damage.

Alcohols: These irritate mucous membranes. Methanol induces blindness through ingestion or prolonged inhalation.

Aldehydes and ketones: Inhalation, absorption, or ingestion of these substances irritates tissues and produces narcotic effects.

Alkalies: Sodium and potassium hydroxides and ammonium hydroxide cause severe tissue burns (especially destructive to eye tissue) and bronchial spasms.

Asphyxiants: Carbon monoxide, carbon dioxide, cyanide, and cyanogen compounds reduce the oxygen-carrying capacity of the blood; stop oxidation in tissues through destruction of enzymes; and displace atmospheric oxygen.

Carbon monoxide: Prolonged exposure renders the hemoglobin of red blood cells ineffective for the transport of oxygen. Results are toxic and may prove deadly.

Compounds of sulfur, phosphorus, nitrogen: These substances corrode the skin and destroy respiratory tissues.

Cyanides: Absorption, inhalation, or ingestion of cyanides produces toxic effects.

Esters: Exposure causes tissue poisoning and irritation.

Ethers: Inhalation produces a powerful narcotic effect. See section I, "Use and Disposal of Ethers," in this chapter.

Halogens: Halogens are corrosive; highly irritating to tissues.

Hydrocarbons: Inhalation causes irritation and tissue destruction. *Prolonged exposure is very dangerous.* Chlorinated varieties form toxic phosgene gas when burned.

Irritants: Ammonia, phosphoric halides, hydrogen chloride, chlorine, bromine, and hydrogen sulfide damage respiratory tissues.

Mercury: The handling of mercury or inhalation of its vapors causes tissue poisoning. Toxic effects are compounded with prolonged exposure.

Metal fumes: The fumes of mercury and zinc poison tissues, causing nausea and fever, even death. *Always use a fume hood.*

E Steps for Establishing a Safer Chemicals Storage Area

The issues of safe storage and use of chemicals and the supervision of laboratory safety are addressed in several sections of the *Education Code* and the *California Code of Regulations, Title 8* (see excerpts in Appendix B). The following is a summary of some of the relevant stipulations in those codes:

- Each school offering laboratory work is urged to designate a trained member of the professional staff as the person "responsible for the review, updating, and carrying out of the school's adopted procedures for laboratory safety" (*Education Code* Section 49341[b]).
- School districts are encouraged "to take steps to ensure hazardous materials are properly used and stored" (*Education Code* Section 49401.5 [a]).
- School districts shall have guidelines "for the regular removal and disposal of all chemicals whose estimated shelf life has elapsed" (*Education Code* Section 49411[b]).
- Employers are required to have a written hazard communication program for employees working in laboratories in which the employees may be exposed to hazardous substances except for those laboratories "under the direct supervision and regular observation of an individual who has knowledge of the physical hazards, health hazards, and emergency procedures associated with the use of the particular hazardous substances involved and who conveys this knowledge to employees in terms of safe work practices." Such excluded laboratories must also maintain labels and material safety data sheets of "incoming shipments of hazardous substances and ensure that they are readily available to laboratory employees" (*California Code of Regulations, Title 8,* Section 5194 [b]).

Note: Preparation of a written hazard communication program may not be necessary if the school can show that the required elements of Section 5194 are contained in the school's chemical hygiene plan, prepared pursuant to the *California Code of Regulations, Title 8,* Section 5191. (See the introductory paragraphs of this chapter and the relevant code sections reprinted in Appendix B.) School districts or school sites should determine the necessity for writing and implementing a written hazard communication program by examining the extensive excerpts from the *California Code of Regulations, Title 8,* Section 5194, cited in Appendix B.

The requirements noted above point to the necessity of establishing a chemicals storage area that is as safe as possible and developing a plan that will ensure the continued maintenance of the area in a safe manner.

Start as soon as possible. Carefully plan each step. The present condition may have existed for some time and is not likely to deteriorate significantly while you assess your situation and examine your options. Your planning and implementation should result in a chemicals storage area that has the following characteristics:

☐ The area is clean and orderly.
☐ A telephone is readily available.
☐ A current list of emergency telephone numbers is posted.
☐ Emergency procedures are up-to-date and posted.
☐ An appropriate first-aid kit is available.
☐ An appropriate spill kit is available.
☐ Safety equipment and supplies (goggles, aprons, face shield, fire blanket, fire extinguisher, eyewash, spill pillow, and, if appropriate, deluge shower, safety shields, and fume hood) are available and functional.
☐ There are no chemicals in storage that have been designated unsafe for school laboratory use (see Tables 1 and 2).
☐ Only chemicals that are used are stored (chemicals not needed have been disposed of).
☐ Chemicals on hand will be consumed essentially within the next year (except for unlimited-shelf-life items, such as iron filings).
☐ Chemicals are arranged for storage in compatible groups.
☐ Chemicals are properly labeled and stored in appropriate containers.
☐ A material safety data sheet (MSDS) is on file for each chemical that is received in the normal course

of the school year and is made accessible to teachers and students for review.

- ☐ There is a continual up-to-date inventory of all chemicals, including quantity, location, date of purchase, shelf life, and projected disposal date.
- ☐ No chemicals are stored above eye level.
- ☐ No chemicals are stored on the floor.
- ☐ Shelves or cabinets are secured firmly to the walls.
- ☐ Earthquake lips or barriers are in place on storage shelves.
- ☐ Storage cabinets for corrosive chemicals (separate cabinets for acids and for bases) are on site and are appropriately used.
- ☐ A storage cabinet for flammables is on site and is appropriately used.
- ☐ Poisons are secured.
- ☐ The storage area temperature never exceeds 25°C (75°F).
- ☐ The storeroom door is self-closing and is locked.
- ☐ There is adequate ventilation (including a fume hood, if needed), and the area is isolated from the rest of the building. Room air is changed at least four times per hour.
- ☐ Compressed gas cylinders are secured upright to the wall, with caps in place. Flammable gases are

TABLE 1
Explosive Chemicals
(for Immediate Disposal *Only* by Explosive Technicians)

Substance	Special Note
Benzoyl Peroxide	Benzoyl peroxide may be exploded by heat, shock, or friction.
Carbon Disulfide	The flashpoint (-30°C) is well below room temperature, and small amounts of the vapor in air can be explosive.
Diisopropyl Ether (if stored longer than 12 months)	This chemical becomes dangerous on aging. If its age is unknown or if it has been in storage for more than 12 months, you should assume that explosive peroxides have formed. If stored for less than 12 months, it can be disposed of by placing it in the fume hood, removing the cap, and allowing the liquid to evaporate.
Ethyl Ether/Diethyl Ether (if stored longer than 12 months)	See the notes for diisopropyl ether.
Nitrogen Triiodide	When it is dry, it will explode on being touched, vibrated, or heated slightly; even a puff of air will cause an explosion. May be stored in wet ether.
Perchloric Acid	Although the 70 percent perchloric acid/water mixture is not explosive by itself, the use of perchloric acid often leads to the formation of perchlorates, which are very explosive. Perchloric acid may be set aside in a safe storage area until commercial disposal is arranged.
Phosphorous (white/yellow)	Phosphorous is packed under water and will ignite spontaneously on contact with air at 30°C.
Picric Acid	Picric acid should always contain 10 to 20 percent water, and bottles should be disposed of after two years. Dry picric acid is explosive and can be detonated by shock or heat. Bouin's solution contains picric acid.
Potassium Metal	Potassium metal becomes dangerous with age. It forms explosive peroxides if not stored under kerosene.
Sodium Azide	Sodium azide is very unstable and explosive. Keep it away from heavy metals.

separated from oxidizing gases by a one-hour fire wall or at least 25 feet (7.5 m).

☐ There are one or more nonreactive waste receptacles made of plastic or crockery.

The following seven-step procedure is based on the assumption that you have not inventoried your chemicals storage area and purged it of dangerous and unnecessary chemicals in recent years or that you are starting with a chemicals storage area that is unfamiliar to you. However, you already may have accomplished much of this suggested procedure.

Step 1: Assignment of Responsibility for Laboratory Safety

Several legal citations indicate that persons knowledgeable about the safe use and storage of hazardous chemicals should be assigned responsibility for laboratory safety at the school district and school-site levels (*California Code of Regulations, Title 8*, sections 5191 and 5194; *Education Code* sections 49341 and 49411; and *Health and Safety Code* Section 25500 et seq.). Logically, the school-site administrator would have the responsibility for assigning such a person at the school-site level. The school-site administrator should carefully seek out and assign the staff person who has the greatest knowledge of and expertise in laboratory safety, giving special consideration to a person with knowledge of chemical processes and hazardous materials management.

Step 2: Inventory and Removal of Explosives

It is prudent to identify and dispose of any explosives that may be present to eliminate the most acutely dangerous materials. Then it is possible to proceed with subsequent steps in relative safety.

Note: During your initial inventory, if any of the chemicals listed in Table 1 are found in the area, the containers should ***not*** *be touched or moved by anyone other than a trained county sheriff or police bomb squad or other qualified official.* If any explosive chemicals are present, call the appropriate district staff person or the local fire or sheriff's department.

Caution: The list in Table 1 is not a comprehensive list of all possible explosive chemicals. It is a list of chemicals that have, in the past, been recommended for use by various laboratory manuals and curriculum guides and, therefore, are most likely to be present in the school laboratory. Be alert for other explosives as you search for the ones noted in Table 1. For methods of disposal, consult *Code of Federal Regulations, Title 49*, for the specific hazard class for each explosive found.

Once the explosives have been removed, it is appropriate to make preparation for the storage and transportation of hazardous materials. Some of the following steps can and should be done simultaneously.

Step 3: Chemicals Inventory

1. *Purpose of the inventory.* The inventory will enable you to:
    a. Meet the requirements of *Health and Safety Code*, Chapter 6.95, which requires that an annual inventory be submitted to an administering agency (probably the county department of health services). In many instances the local fire department or designated city or county agency also requests such an inventory.
    b. Learn of any extremely hazardous chemicals (acutely toxic, carcinogenic, mutagenic, etc.) that should be disposed of immediately. See step 6 for instructions for disposal of extremely hazardous (waste) chemicals. (See relevant legal citations in Appendix B.)
    c. Assess which chemicals are not used and should be disposed of.
    d. Provide a cursory check of whether the chemicals have deteriorated and are no longer usable. (Most chemicals are affected very little by age; however, some oxidize, others either collect or lose moisture, and still others become more hazardous.) Loose or rusted caps may provide a basis for a closer look.
    e. Relabel items when labels become obscure. Identify any chemicals whose labels are missing. All hazardous chemical waste must be identified before disposal.

Although all the preceding purposes are important and must be dealt with, it is best to complete the inventory first and then carry out the steps for the collection, storage, and disposal of waste. Finish by reshelving the chemicals in compatible groups.

2. *Preparation for the inventory.* Follow the precautions described below:
    a. Use at least two persons (no students), for safety purposes, to perform the inventory.

b. Allow sufficient uninterrupted time to complete the task.
c. Be sure a telephone or other reliable means of communication is available.
d. Wear proper protection (including goggles, apron, and gloves) for the task.
e. Have safety items (e.g., fire extinguisher, eyewash, spill kit, fume hood, fire blanket, and half-mask respirator) available.
f. Have a flashlight and ladder available, if necessary.
g. Be sure the room is properly ventilated.
h. Have a plastic broom, plastic dustpan, and plastic receptacle available for cleanup.
i. Be prepared to encounter unknown substances.
j. Have alternate containers (bottles, cans, resealable plastic bags) available in case you discover a broken container.
k. Have replacement caps available.
l. Use a method of recording the inventory that will allow you perpetually to maintain the inventory.
m. Notify school and fire authorities and maintenance personnel of the inventory undertaking.
n. Plan how you will record the chemicals on a substance-by-substance basis.

3. *Methods of recording inventory.* Some suggestions are as follows:

   a. Use a small pocket tape recorder and read into it the chemical name, the concentration or purity, the type of container, the size of the container, and the approximate amount of chemical in the container (e.g., "Ferric oxide, practical, in a 500-gram plastic container, about one-third full"). If you expect a clerk or someone not familiar with chemicals to transcribe the list, you might want to spell the name of each substance.
   b. Use a computer software chemical inventory system that contains such features as printouts for all chemicals used in the laboratory, with their related hazard class; the location of the chemical in the laboratory; the minimum desirable amount to be maintained; and the amount available at the site.
   c. Start alphabetically. Write the name, type of container, and quantity of each chemical in storage; leave spaces to add hazard class, future storage, disposal information, and so forth. (See Appendix M for a sample chemical inventory.)

Step 4: Collection of Laboratory Residues and Waste

1. *Solids.* Use the following procedures:
   - Solid residues should be collected in stone crocks or plastic containers, not in a wastebasket.
   - A separate container (with a *hazardous waste* label) should be provided for any flammable solid waste substance.
   - Solid residues should not be put in sinks or toilets. Plumbing problems can be avoided by providing a screen or strainer for the drain in each sink.
2. *Liquids.* Observe the following precautions:
   - Pour flammable liquids into a safety can labeled *hazardous waste.*
   - Never flush flammable liquids into the plumbing system. Dangerous explosions might result from an accumulation of vapors.

Step 5: Temporary Storage and Eventual Transportation of Hazardous Waste

One can assume that any secondary school has chemicals that are included in the Cal/OSHA director's "Hazardous Substances List" (*California Code of Regulations, Title 8,* Section 339, and *California Code of Regulations, Title 22,* Section 66261.126). These chemicals are found not only in the science department but also in the art department, industrial arts department, and custodial office. Your site generates hazardous waste, and school officials must be prepared to store and dispose of the waste appropriately.

Hazardous waste treatment and disposal practices. Hazardous waste may not be disposed of in the regular trash or on the surface of the ground. In addition, it may not be dumped into the sewer system (sink or toilet) unless you have an industrial waste discharge permit from your sewer agency.

If you wish to dispose of, treat, or recycle your hazardous waste to render it less hazardous or nonhazardous at your business location, you must obtain a Hazardous Waste Facility permit from your regional office of the Department of Toxic Substances Control (see Appendix K and *Health and Safety Code* Section 25143.2).

To determine the kind and quantity of nonhazardous chemicals (waste) that may legally be flushed down sink drains, school officials should consult with their county health department and regional water quality control board and obtain approval from the local publicly owned treatment facility. If the school site is serviced by on-site sewage disposal fields, there may be severe limitations on what may be flushed down the drain. Check with the local department of health services for advice.

In any case it will probably be necessary to store some hazardous waste on site temporarily and have a commercial hazardous waste transporter dispose of it. These storage and disposal processes are likely to be coordinated and enforced by your county department of health services, which you should contact for assistance, advice, and specific procedures.

Storage of hazardous waste. Waste storage practices are designed to minimize the seriousness of a hazardous waste accident, should one occur. Although most science departments do not generate more than 100 kilograms (220 pounds) of hazardous waste or 1 kilogram (2.2 pounds) of extremely hazardous waste during any calendar month, a school campus might collectively generate those amounts, considering the waste generated by industrial arts, auto shop, and other on-campus maintenance activities. Therefore, schools should be aware that there is a 90-day storage limitation for hazardous waste when a site has accumulated the quantities noted above (*Health and Safety Code* Section 25123.3b and *California Code of Regulations, Title 22*, Section 66262.34).

Storage practices must include the following:

- Store hazardous waste in sturdy, nonleaking containers (storage drums) with close-fitting lids, which must be kept closed when waste is not being added or removed. (Contact the appropriate school district official or consult the yellow pages of the telephone directory for sources of proper containers.)
- Handle the waste in containers and in a way that minimizes the possibility of spills and escape of waste into the environment. For example, waste chemicals should remain in their shelf container when placed in storage drums; the chemicals themselves should be segregated for separate handling and disposal.
- Label the containers accurately with waterproof labels. Labels must specify the words *Hazardous Waste*, the composition and physical state of the waste, the hazardous properties of the waste (e.g., flammable, reactive), and the name and address of the generator.
- Include on each container the date on which the period of accumulation began.
- Inspect the storage area weekly for deteriorating or leaking containers (*California Code of Regulations, Title 22*, sections 66265.170–66265.174).
- Store the drums no less than 15 meters (50 feet) from property lines if the waste is ignitable or reactive (*California Code of Regulations, Title 22*, Section 66265.176).

Transportation of hazardous materials or waste. The *Health and Safety Code* Section 25163(c) (see Appendix B) states that a person hauling hazardous waste to a permitted hazardous waste facility in quantities not exceeding five gallons or 50 pounds does not need to be registered with the California Department of Toxic Substances Control as a hazardous waste transporter if the person meets all the following conditions:

> (1) The hazardous wastes are transported in closed containers and packed in a manner that prevents the containers from tipping, spilling, or breaking during the transporting.
>
> (2) Different hazardous waste materials are not mixed within a container during the transporting.
>
> (3) If the hazardous waste is extremely hazardous waste or acutely hazardous waste, the extremely hazardous waste . . . was not generated in the course of any business and is not more than 2.2 pounds.
>
> (4) The person transporting the hazardous waste is the producer of that hazardous waste, and the person produces *not* more than 100 kilograms of hazardous waste in any month.
>
> (5) The person transporting the hazardous waste does not accumulate more than a total of 1,000 kilograms of hazardous waste on site at any one time.

Although passenger vehicles generally are exempt from the requirements of posting placards and labeling containers, trucks are *not* exempt and must comply with the Department of Transportation's regulations. Anyone transporting hazardous materials should place the materials as far away from themselves as possible. Care should be taken to separate the chemicals according to their compatibility. Absorbent packing materials add an extra dimension of safety in case of accidental spills.

Other avenues for disposing of hazardous waste are as follows:

1. *"Milkrun operations" for transporting hazardous waste.* Schools generating hazardous waste can greatly reduce their pickup and disposal costs by participating in "milkrun operations" (*California Code of Regulations, Title 22,* Section 66263.42; see Appendix B). This regulation allows registered transporters to commingle waste "from any number of generators." Since much of the waste handled in a milkrun operation is recyclable, the cradle-to-grave liability will be minimized. Schools should be aware of the following:
    - In a milkrun operation the transporter completes both the generator's and transporter's sections of the "Uniform Hazardous Waste Manifest."
    - The generator is responsible for obtaining (from the transporter) a receipt or shipping paper, which must contain the information listed in *California Code of Regulations, Title 22,* Section 66263.42(d)(3)(A–I) (see Appendix B). The papers must be kept for three years.
    - The operator of the treatment, storage, or disposal facility (TSDF) that receives and processes the generated waste will send a copy of the "Uniform Hazardous Waste Manifest" to both the Department of Toxic Substances Control and the transporter but *not* to the generator.
    - The generator must have an Environmental Protection Agency (EPA) identification number. This number is needed to remove hazardous waste legally from the site and to process the "Uniform Hazardous Waste Manifest." You can apply for a number by calling the Department of Toxic Substances Control at (916) 324-1781; allow several weeks for the issuance of your number.[6] Some school districts have one number for the whole district; in other districts each high school has a number.

    Some waste cannot be transported in milkrun operations. If you have questions about whether specific substances can be picked up in a milkrun, see *California Code of Regulations, Title 22,* Section 66263.42(a)(1–8) in Appendix B or contact your regional office of the Department of Toxic Substances Control (see Appendix K for your nearest regional office). For laboratory chemicals that are not transportable on milkruns, the generator is required to use the "Uniform Hazardous Waste Manifest" (*California Code of Regulations, Title 22,* Section 66262.10 et seq.). A sample "Uniform Hazardous Waste Manifest" and ordering information are included in Appendix B.

2. *Use of a registered transporter of hazardous waste.* Hazardous waste exceeding 50 pounds (22.5 kilograms) or 5 gallons (19 liters) must be transported only by registered hazardous waste transporters to a state-permitted treatment, storage, or disposal facility. These transporters are registered by the Department of Toxic Substances Control. Hazardous waste must be packed and labeled for transport in accordance with applicable Department of Transportation regulations (see Appendix N).

Biennial reports. On March 1 of each even-numbered year, you will be required to submit a report to the Department of Toxic Substances Control on waste generated at your site during the previous odd-numbered year. Careful recordkeeping of all the school-site manifests and receipts will be helpful in completing the appropriate forms. For the past two reporting years, generators of less than 1,000 kilograms per month (1,200 kg/year) of waste have been exempt from this process. Contact your regional office of toxic substances control for more information. If you have an EPA number, you will receive a report request.

Once the equipment and details are in place for waste storage and transportation, a complete chemicals inventory should be made (see step 3).

Step 6: Disposal of Waste

Note the similarities of these procedures to those for conducting a chemicals inventory (see step 3). Therefore, it is often efficient to do both at the same time.

In preparing waste for disposal, you should follow these procedures:

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[6] On applying for an EPA identification number, you will receive a package from the Department of Toxic Substances Control called "Notification of Hazardous Waste Activity." If you need assistance in completing the package, call (916) 324-1781. Most likely, your school (unless new) already has an EPA number.

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1. Use at least two persons (no students) to perform the procedures and thereby ensure safety.
2. Allow sufficient uninterrupted time to complete the task.
3. Be clothed properly (including goggles, apron, and gloves) for the task.
4. Have safety items (e.g., fire extinguisher, fire blanket, eyewash, spill kit, and fume hood) available.
5. Have a flashlight and ladder available, if necessary.
6. Be sure that the room is properly ventilated.
7. Have a plastic broom, plastic dustpan, and plastic receptacle available for cleanup.
8. Be prepared to handle unknown substances if they are encountered.
9. Have alternate containers (bottles, cans, resealable plastic bags) available in case you discover a broken container.
10. Have replacement caps available.
11. Notify school authorities and maintenance personnel of the reshelving to be undertaken.
12. Adapt plastic water bottles for solid residue disposal by cutting off the top of the bottle and punching small drain holes in the bottom. Place the container in the sink for the disposal of solids. Only small amounts of nonregulated, nonflammable, water-miscible liquids may go down the drain. Check with your local public works department or sanitation district (Water Quality Control Division) for specified limitations on disposable items.
13. Dispose of small quantities of nonregulated, nonflammable, water-miscible liquid residues by pouring them down the sink drain and using large amounts of water to dilute and flush the material through the plumbing system. Do not pour acids into a porcelain-lined sink. If corrosive, caustic, poisonous, or other controlled liquids need to be discarded, consult with the appropriate school district staff member.
14. Discard nonflammable solid waste and broken glassware in a container separate from the trash container. Either of those kinds of waste substances can present a serious hazard to custodial employees during collection and disposal. Broken glassware should be wrapped in heavy paper, taped, and properly labeled DANGER. BROKEN GLASS.
15. Arrange for emergency communications should a serious problem occur, such as a spill or a fire.
16. Have space available in which to place the materials temporarily.
17. Do as much preliminary housekeeping as possible to avoid physical obstacles that could lead to accidents.
18. Eliminate all sources of ignition.
19. Identify and label shelves or cabinet spaces for each category if reshelving.
20. Have the right information and labels to do the job if you plan to label each item by its hazard class.
21. Plan how you will accommodate (or dispose of) the many bottles of solutions prepared and stored during recent years.

Disposal of extremely hazardous chemicals. The most serious potential explosives should have been disposed of in step 2. However, there are additional chemicals whose potential hazards outweigh any benefit they may provide to the instructional program. None of the chemicals shown in the list in Table 2 should be stored in schools; if any are present, they should be properly disposed of (the hazard class is included in the list for disposal purposes). In addition, all schools that use, handle, or store carcinogenic chemicals (whether stored from the past or used at present) should be registered with Cal/OSHA (see Appendix O for a "Report of Use" form).

Special permits are no longer required for the storage, treatment, transportation, or disposal of extremely hazardous waste. Such waste is subject to the same requirements as those for hazardous waste. However, producers and transporters of extremely hazardous waste are required to notify and to send a tax return to the state Board of Equalization each year. An annual fee is to be paid on receipt of a billing from the board (see Appendix B, *Health and Safety Code* sections 25153 and 25205.7[o]). To acquire a reporting form and tax return, write or call the Environmental Fees Division, P.O. Box 942879, MIC: 57, Sacramento, CA 94279-0001; telephone (916) 322-9534.

Disposal of excess and deteriorated chemicals. Once the extremely hazardous chemicals have been disposed of, an assessment must be made about the remaining inventory to determine which portion will be used during the next year (or at most, two years). The remainder should be appropriately disposed of. The process of determining which chemicals to keep should involve all staff members who draw from the

TABLE 2
Extremely Hazardous Chemicals for Prompt Disposal

Chemical Name	NTP	IARC	California H and W	Hazard Class (DOT)	CAS Number
2-Acetylaminofluorine	Anticipated		X	Not listed	53-96-3
Acrylamide (neuro toxin)	Anticipated	2A	X	Keep away from food/Poison 6.1	79-06-1
4-Aminodiphenyl	Known	1	X	Keep away from food/Poison 6.1	92-67-1
Aniline		3	X	Poison 6.1	62-53-3
Arsenic Powder	Known	1	X	Poison 6.1	7440-38-2
Arsenic Trioxide	Known	1	X	Poison 6.1	1327-53-3
Asbestos	Known	1	X	Misc. hazard 9	1332-21-4
Benzene	Known	1	X	Flammable liquid 3	71-43-2
Benzidene	Known	1	X	Poison 6.1	53 1851, 53 1862
Beryllium	Anticipated	1	X		7440-41-7
Beryllium Compounds	Anticipated	1	X		
Cadmium Powder	Anticipated	1	X	Poison 6.1	7440-43-9
Cadmium Salts	Anticipated	1	X	Poison 6.1	
Carbon Tetrachloride	Anticipated	2B	X	Poison 6.1	56-23-5
Chloroform	Anticipated	2B	X	Poison 6.1	67-66-3
Chromium (VI) Oxide and all hexavalent chromium compounds	Known	1	X	Oxidizer corrosive 5.1	1333-82-0
Cobalt		2B	X		7440-48-4
Cobalt II Oxide		2B	X		1307-96-6
p-Dichlorobenzene	Anticipated	2B	X	Keep away from food/Poison 6.1	106-46-7
3,3-Dichlorobenzidine and salts	Anticipated	2B	X	Not listed	91-94-1
4 Dimethylaminoazobenzene	Anticipated	2B	X	Not listed	60-11-7
Ethylene Dichloride (1,2 Dichloroethane)	Anticipated	2B	X	Flammable liquid/Poison 3	107-06-2
Formaldehyde	Anticipated	2A	X	Misc. hazard 9	50-00-0
Hydrazine (anhydrous)	Anticipated	2B	X	Flammable liquid/corrosive/ Poison 3	302-01-2
Hydrofluoric Acid				Corrosive material/Poison 8	7664-39-3
Lead Acetate	Anticipated	2B	X	Keep away from food/Poison 6.1	301-04-2
Lead Arsenate	Known	1	X	Poison 6.1	7784-40-9
Methylchloromethyl Ether	Known	1	X	Not listed	107-30-2
4-4' Methylene Bis (2-Chloroaniline)	Anticipated	2A	X	Poison 6.1	101-14-4
Methylene Chloride (Dichloromethane)	Anticipated	2B	X	Keep away from food/Poison 6.1	75-09-2
Alpha Naphthylamine		3	X	Poison 6.1	134-32-7
Beta Naphthylamine	Known	1	X	Poison 6.1	91-59-8
Nickel Powder	Anticipated	2B	X	Metal	7440-02-0
Nickel Compounds	Anticipated	1	X	Metals	
4-Nitrobiphenyl		3	X	Not listed	92-93-3
Beta Propiolactone	Anticipated	2B	X	Not listed	57-57-8
Sodium Arsenate	Known	1	X	Poison 6.1	7631-89-2
Sodium Arsenite	Known	1	X	Poison 6.1	7784-46-5
Vinyl Chloride	Known	1	X	Flammable gas 2.1	75-01-4

Continued on next page

TABLE 2 (Continued)

Notes on Classification of Carcinogens

The carcinogenicity findings depicted in Table 2 were derived by three agencies, each using somewhat different criteria with which to classify chemicals. The agencies and classifications unique to each agency are identified below:

National Toxicology Program (NTP)

"Known" carcinogen: substance for which there is evidence (from human studies) indicating a causal relationship between exposure to the substance and human cancer

"Anticipated" carcinogen: substance for which there is limited evidence of its carcinogenicity in humans or sufficient evidence of its carcinogenicity in experimental animals

International Agency for Research on Cancer (IARC)

Group 1: agent that is carcinogenic to humans; used only when there is sufficient evidence of its carcinogenicity in humans

Group 2A: agent that is probably carcinogenic to humans; used when there is limited evidence of its carcinogenicity in humans and sufficient evidence of its carcinogenicity in experimental animals

Group 2B: agent that is possibly carcinogenic to humans; used either when there is limited evidence of its carcinogenicity in humans but an absence of sufficient evidence of such in experimental animals or when there is inadequate or nonexistent evidence of the agent's carcinogenicity in humans and sufficient evidence of such in experimental animals

Group 3: agent that is not classifiable about its carcinogenicity in humans (Agents are placed in this group when they do not fall into any other group.)

Group 4: agent that is probably not carcinogenic to humans; used when the evidence suggests its lack of carcinogenicity in both humans and experimental animals

California Health and Welfare Agency (California H and W)

An *X* marked in this column denotes a substance whose characteristics match one or more of the following criteria: (1) the substance has been shown through scientifically valid testing to cause cancer or reproductive toxicity; (2) an authoritative body, such as the U.S. Environmental Protection Agency, U.S. Food and Drug Administration, IARC, National Institute for Occupational Safety and Health (NIOSH), or NTP, has identified the substance as causing cancer or reproductive toxicity; or (3) a state or federal agency has required the substance to be identified as causing cancer or reproductive toxicity. (See *California Code of Regulations, Title 22,* Section 12000, Safe Drinking Water and Toxic Enforcement Act of 1986, Chemicals Known to the State to Cause Cancer or Reproductive Toxicity).

If any of the chemicals in Table 2 are found in your school laboratory, they should be removed from the premises promptly by following the procedures specified in this handbook.

storage area for the instructional program. When the decision is made about what to keep, the remainder can be disposed of by a commercial disposal service (see step 5).

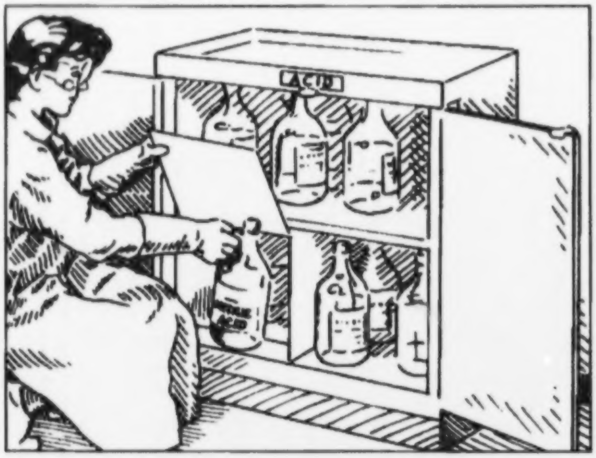
Step 7: Storage Patterns

A number of safe storage patterns for hazardous chemicals have been developed and used in schools, colleges, and universities. The chemicals are sometimes arranged alphabetically and often by compatibility (or incompatibility) of the chemicals. Although some patterns are better than others, none seems to be completely acceptable without making special provisions for certain chemicals that must be isolated for safety. The common alphabetical shelving pattern must be abandoned in favor of one, for example, that separates the oxidizers from metals and separates the flammables, the corrosives, and the poisons.

A single safe and practical storage compatibility system must be agreed on and used by all site staff. A mix of systems on one site could prove very dangerous. A system suggested for use in all California secondary schools is described below, with the ten recommended storage compatibility groups noted in the accompanying box. In the recommendations that follow, special consideration has been given to separating and isolating chemicals and preventing their commingling should a serious disaster occur, such as a major earthquake or fire. This system also considers the hazard classes established in the *Code of Federal Regulations, Title 49* (Transportation).

All storage shelves and cupboards should be fixed rigidly to the walls and be equipped with restraining lips, wires, or other barriers. Storage of chemicals within or near the main chemicals storage area should be selected on the basis of described needs (see diagram on page 44). The storage locations may be lockable cupboards, under-the-counter cabinets, or especially constructed (or purchased) cabinets, such as the cabinets for acids, bases, and flammables. Each cabinet chosen should be clearly and permanently (or at least semipermanently) marked for its designated storage purpose. As much as possible, keep the chemicals in any special storage containers used by the supplier in storing and shipping.

Chemicals should be stored only in approved, locked cabinets within designated science storage rooms. Such storage rooms must be well ventilated and dry and must have adequate protection from direct sunlight. Lighting should be adequate. All cabinets should be locked when not in use, and the storage room should be kept locked. The instructor should be the only person with free access to the storage room. No student should be permitted in the storage room unless accompanied and supervised by the instructor.



Recommendations for the safe storage of chemicals are as follows:

1. Chemical substances must be stored in an orderly manner. All substances must be properly labeled, and an efficient retrieval scheme must be available to locate the chemicals. Alphabetical order is not appropriate *except* within compatible groups. Instead, refer to the recommended storage compatibility categories in the box on page 42.
2. Properly labeled safety containers must be used to store liquids that are highly volatile, potentially explosive, or flammable. Local fire departments should be consulted about minimum quantities for which safety containers are required. If possible, highly corrosive chemicals, such as inorganic acids and bases, should be stored in separate corrosives storage cabinets, which are:
    - Constructed of dense one-inch plywood and contain no uncoated metal hinges or locks (Hinges and locks fabricated from wood or an appropriate plastic material are preferred.)
    - Fabricated to ensure that shelf supports will not corrode and allow shelves to collapse
    - Provided with a recess or pan on the floor that will collect corrosives and not suffer damage
    - Constructed in compliance with local safety requirements
    - Equipped with self-closing doors, with locks, and painted with an intumescent fire-resistant paint
    - Marked in large, contrasting letters CORROSIVES, ACID, or other appropriate inscription
3. Flammable liquids should never be stored in open or ordinary metal cabinets. Ordinary metal cabinets provide no insulation from heat and will produce more shrapnel if an explosion occurs. Cabinets approved for flammable liquids should be constructed of dense one-inch plywood with a recess or pan on the floor to collect spills. The cabinets should be painted with intumescent- or fire-resistant paint; have a self-closing door, a positive latch, and locks; and be clearly marked in large contrasting letters FLAMMABLE. KEEP FIRE AWAY! Verify that cabinets are in compliance with local safety requirements.
4. Spacing between containers must be adequate to ensure proper air circulation and the safe retrieval of chemicals. Therefore, do not overorder.
5. Extremely hazardous, unlabeled, or unidentifiable chemicals must not be kept in schools. Follow recommended procedures for the disposal of dangerous, unwanted, or outdated chemicals.
6. Periodic *on-site* inspections of chemical storage cabinets must be conducted. (See Appendix H, "Safety Checklist for Science Instruction, Preparation, and Storage Areas.")
7. An updated inventory list must be maintained for all chemical substances.
8. Bottles containing acids or volatile organic liquids should be kept away from heating pipes or direct sunlight to avoid pressure buildup within the storage vessel.

Chemical Storage Compatibility Categories

1. **Metals.** All metals except mercury (see item 8). Phosphorus (red only; white or yellow phosphorus not recommended for school usage) should also be stored here. Flammable solids should be stored in the flammables cabinet. *Location:* Keep separate from oxidizers (including ammonium nitrate), halogens, organic compounds, and moisture.
2. **Oxidizers**. All except ammonium nitrate. Includes nitrates, nitrites, permanganates, chlorates, perchlorates, peroxides, and hydrogen peroxide 30 percent or greater. *Location:* Keep separate from metals, acids, organic materials, and ammonium nitrate. Preferably, isolate oxidizers from the flammable liquids storage cabinet by a minimum of eight meters (25 feet) or by a one-hour fire wall.
3. **Ammonium nitrate.** Store in isolation from all other chemicals, especially acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, and finely divided organic combustible materials.
4. **Bases.** Strong bases—sodium hydroxide, potassium hydroxide, and other regulated bases—and ammonium hydroxide. Store in a dedicated corrosive chemicals storage cabinet that has an interior constructed entirely of corrosion-resistant materials.
5. **Acids.** Inorganic (except nitric acid) and regulated organic acids. Store in a dedicated corrosive chemicals storage cabinet that has an interior constructed entirely of corrosion-resistant materials.
6. **Nitric acid.** Must be stored separately from acetic acid. Store either in an isolated compartment in the acids cabinet or in special Styrofoam containers available for that purpose from vendors of chemicals. Fuming nitric acid should never be used.
7. **Flammables.** Store in a dedicated flammables storage cabinet painted with heat/flame-resistant paint. Preferably, isolate flammables from all oxidizers by a minimum of eight meters (25 feet) or by a one-hour fire wall.
8. **Poisons.** Cyanides (no longer recommended for school programs), mercury and mercury compounds, nicotine, and other poisons. *Location:* Use a lockable drawer remote from the acids storage cabinet.
9. **Compressed gases.** Cylinders must be chained or strapped to the wall, with caps on tight. *Location:* (a) Keep oxidizing gases remote from flammable liquids, metals, and flammable gases; (b) keep flammable gases remote from oxidizers and oxidizing gases by a distance of eight meters (25 feet) or by a one-hour fire wall.
10. **Low-hazard chemicals.** Many of the salts not otherwise specified (of course, *not* the nitrates), weak bases, oxides, carbonates, sulfides, dyes, indicators, stains, noncorrosive organic acids, amino acids, sugars, and so forth. Store on open shelves that have earthquake barriers.

9. Bottled gas cylinders should be secured to a wall or counter to prevent upsetting the cylinders. The rupture or unintentional opening of the release valve may cause serious personal injury and destruction of laboratory facilities, especially if the cylinder is not secured and becomes a projectile.
10. Larger gas cylinders must be kept in the cart provided for their transport. Valves should be in perfect working order. When not in use, each cylinder must be secured against movement; that is, each must be held by a sturdy chain or strap connected to ring bolts that will not pull free. The cylinders must be located within an approved storage area. Move large gas cylinders only when regulator valves have been removed and safety covers have been installed.

A relatively safe and practical pattern for storage of chemicals is one that has separate storage provisions for different categories of chemicals (see diagram on page 44).

F Labeling of Chemical Reagents

Whenever feasible, store chemicals in the containers in which they were received and retain the vendors' labels. Labels on prepared chemical reagent bottles or containers should display the following information (see also Table 3):

1. Generic name of the chemical and its chemical formula
2. Degree of hazard, as designated by the appropriate signal word:
   - DANGER
   - WARNING
   - CAUTION
3. Type of hazard(s), such as the following:
   - *Poison*
   - *Causes burns*
   - *Flammable*
   - *Harmful vapors*
   - *Explosive*
   - *Toxic*
   - *Corrosive*
4. Date of receipt or preparation
5. Precautionary measures, such as the following instructions on how to avoid injury:
   - *Keep away from heat, sparks, or open flame.*
   - *Avoid contact with eyes, skin, or clothing.*
   - *Use only with adequate ventilation.*
6. Instructions in the event of ingestion, contact, or exposure

The example shown here addresses each of the labeling requirements. Proper labels can be obtained from most chemical or safety supply houses.

IN CASE OF CONTACT WITH EYES, FLUSH WITH WATER CONTINUOUSLY FOR 15 MINUTES AND GET MEDICAL ATTENTION IMMEDIATELY.

HCl, Hydrochloric Acid

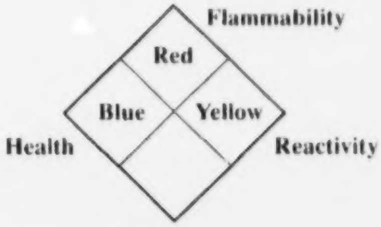
WARNING:

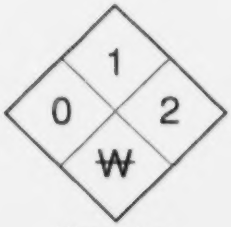
- Causes burns.
- Avoid contact with skin and eyes. Avoid breathing vapor.
- In case of contact, immediately flush skin or eyes with large amounts of water for at least 15 minutes. For eyes, get immediate medical attention.

G Potentially Hazardous Chemicals

Many potentially hazardous chemicals found in school science laboratories are included in the list in Table 3. Chemicals of dubious value because of associated hazards are marked with a single asterisk. Chemicals marked with a triangle are known by the state to cause cancer or reproductive toxicity. District staff are advised to make their own decisions about the acquisition and use of laboratory chemicals. If an especially hazardous chemical is deemed essential to the program, school staff must assume the corresponding responsibility to ensure safe storage and use of the chemical. When in doubt, school staff should contact district staff or other appropriate agencies.

In Table 3 the National Fire Protection Association (NFPA) symbols are provided under the chemical name where applicable. The diamond-shaped diagram (see example below) gives, at a glance, the inherent hazards of the chemical and the order of severity of those hazards under emergency conditions, such as spills, leaks, or fires. The information can be especially useful to firefighters and safety personnel in emergency situations. *The diagram is not intended to identify the nonemergency health hazards of chemicals.*





Magnesium

The diagram identifies the *health, flammability,* and *reactivity* hazards of a chemical (*reactivity* here refers to the instability and water reactivity of a chemical that is likely to explode or burn, not to the corrosive or reactive nature of a chemical) and indicates the order of severity of each hazard by using one of five numeral gradings, ranging from four (severe hazard or extreme danger) to zero (no special hazard). In the diamond-shaped diagram the *health* hazard is identified on the left, *flammability* at the top, and *reactivity* on the right.

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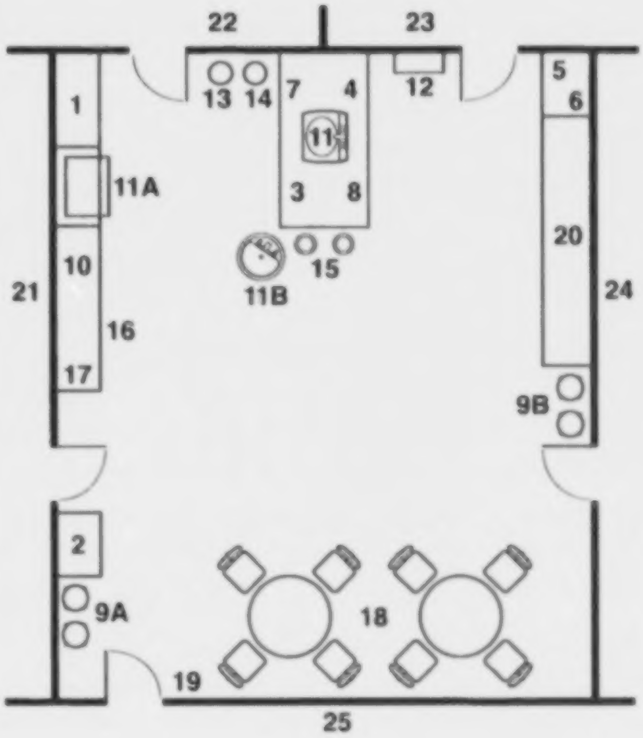
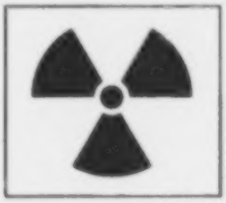
Preparation/Storage Area Diagram



1. Metals storage
2. Oxidizers storage
3. Ammonium nitrate storage
4. Bases cabinet
5. Acids cabinet
6. Isolated nitric acid storage
7. Flammables cabinet
8. Poisons drawer
9A. Compressed gases—nonflammable/oxidizing; chained/strapped to a wall
9B. Compressed gases—flammable; chained/strapped to a wall
10. Low-hazard chemicals storage with earthquake lips; secured to walls
11. Sink/counter with hot/cold water, gas, electricity, exhaust hood, cabinet underneath
11A. Refrigerator
11B. Emergency shower and eyewash station
12. First-aid kit
13. ABC fire extinguisher
14. Fire blanket
15. Plastic waste receptacles
16. Chemical spill kit
17. Chemical inventory system, including MSDS
18. Conference/prep area
19. Emergency evacuation procedure
20. Apparatus/glassware storage cabinets with earthquake lips; secured to walls
21–24. Adjacent classroom laboratories
25. Hall or outside exit; all doors self-closing and lockable

The bottom space is used primarily to identify unusual reactivity with water. A *W* with a line through its center, ~~W~~, indicates a possible hazard in the use of water. Oxidizing chemicals are identified by *OXY* or *OX*, and a radiation hazard by this symbol:



Colored backgrounds or colored numbers usually supplement the spatial arrangement to identify the hazard categories: blue denotes health; red, flammability; and yellow, reactivity. (Because of fiscal limitations, the color code is not used in this handbook.)

The following is a brief summary of the meanings of the numbers in each hazard category and the precautions necessary in a hazardous situation:

Health (blue)

4—A few whiffs of the gas or vapor could cause death. Usually, the wearing of special protective clothing and equipment is required. Examples in this category are hydrogen cyanide and bromine.

3—Materials are extremely hazardous to health. In a hazardous situation persons must wear full protective clothing and breathing apparatus before entering areas holding these materials. Examples in this category are hydrochloric acid and sodium hydroxide.

2—Materials are hazardous to health, but areas may be entered freely by persons using self-contained breathing apparatus. An example in this category is ethyl ether.

1—Materials are only slightly hazardous to health. Self-contained breathing apparatus may be desirable. An example in this category is acetone.

0—No health hazard is present, beyond that of ordinary combustible material.

Flammability (red)

4—This number is used for extremely flammable gases; volatile flammable liquids; and materials that, in the form of dusts or mists, readily form explosive mixtures when dispersed in air. An example is propane.

3—This category indicates liquids that can be ignited under almost all normal temperature conditions; solids that form coarse dusts; solids in shredded or fibrous form that create flash fires; solids that burn rapidly, usually because they contain their own oxygen; and any material that ignites spontaneously at normal temperatures in air. Examples are acetone and methanol.

2—Liquids must be moderately heated before ignition will occur; solids readily give off flammable vapors. An example is kerosene.

1—Materials must be preheated before ignition can occur. Most combustible solids have a flammability rating of 1. Examples are sulfur and magnesium ribbon.

0—Materials will not burn.

Reactivity (yellow)

4—Materials are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures or are sensitive to mechanical or localized thermal shock. An example is picric acid (dry).

3—Materials are capable of detonation or explosive decomposition or explosive reaction but require a strong initiating source or must be heated under confinement before initiation. Materials are sensitive to thermal or mechanical shock at elevated temperatures and pressures or react explosively with water. An example is ammonium nitrate.

2—Materials are normally unstable and readily undergo violent chemical change but do not detonate. Materials can undergo chemical change with rapid release of energy at normal temperatures and pressures and undergo violent chemical change at elevated temperatures and pressures. Materials react violently with water or may form potentially explosive mixtures with water. Examples are sodium peroxide and sodium metal.

1—Materials are normally stable but may become unstable at elevated temperatures and pressures or may react with water to release some energy, although not violently. Examples are zinc metal and red phosphorous.

0—Materials are normally stable, even under fire-exposure conditions, and are not reactive with water.

Table 3 also provides (1) specific labeling information from OSHA, if necessary, for each chemical on the list (when possible, retain vendor's labels); (2) a four-part storage-related code; (3) the potential hazards of the chemical; and (4) advice on first aid. The key to the four-part storage-related code is as follows, using the code for acetone (7/2S/2/FLAMMABLE) as an example:

7[a]/2S[b]/2[c]/FLAMMABLE[d]

[a] Chemical storage compatibility category (See chart on page 42.)

[b] Suggested type of container (When possible, maintain the original container and packaging from the vendor for storage):

1. Glass or polyethylene bottle. W=store under water, surrounded by sand, in a large container; KM=store under kerosene or mineral oil, surrounded by sand, in a larger container
2. Metal can. S=safety can for larger quantities
3. Wax (or plastic) bottle in a container of kaolin or other absorbent material

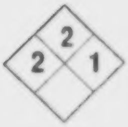
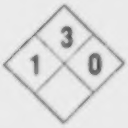
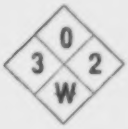
[c] Shelf life

1. Poor—less than one year with special storage
2. Fair to good—up to three years, varies with temperature, humidity, and so forth
3. Excellent/indefinite—essentially indefinite in time and invariant in terms of conditions

[d] Hazard class from *Code of Federal Regulations, Title 49* (Transportation). Provides Department of Transportation (DOT) class/compatibility for commercial disposal. See Appendix N for an explanation of the terms used.

TABLE 3

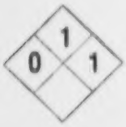
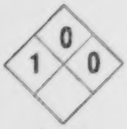
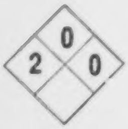
Hazardous Chemicals Reference Table

Name and NFPA Symbol	Label	Hazard	First Aid
Acetic Acid (glacial)  	DANGER! Corrosive. Causes severe burns. Do not get liquid or vapor in eyes, on skin, or on clothing. Keep away from heat and flame. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes get medical attention. Glacial acetic acid freezes at 62°F (17°C). Store at temperatures above 62°F (17°C). If frozen, thaw by carefully moving carboy to warm area. 5/1/3/CORROSIVE 8	Corrosive. Organic acid causes painful wounds when it comes in contact with skin. Toxic by ingestion.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention. Give water to dilute. Do not give emetic.
Acetone  	DANGER! Extremely flammable. Keep away from heat, sparks, and open flame. Keep container closed. Use adequate ventilation. Avoid prolonged or repeated contact with skin. 7/2S/2/FLAMMABLE LIQUID 3	Highly flammable liquid. An irritant to skin, throat, and lungs. Toxic by ingestion.	*External*—Remove victim to fresh air. Irrigate eyes with water. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
Aluminum Chloride (anhydrous)  	Corrosive. Store in a dry, cool area. 5/1/1/CORROSIVE 8	Reacts violently with water to generate heat and hydrogen chloride gas fumes and hydrochloric acid, which are irritating and toxic. Causes burns to skin and eyes. Dust inhalation will irritate or burn membranes. Ingestion can cause severe burns. *Dispose of as extremely hazardous waste.*	*External*—Irrigate eyes and skin with water for 15 minutes. *Internal*—Do not give emetic. Seek immediate medical attention.
Aluminum Chloride (crystal)	10/1/3/Not regulated	Emits toxic fumes when heated to decomposition.	*External*—Irrigate eyes with water for 15 minutes. *Internal*—Soluble forms may be corrosive; do not give emetic. Seek immediate medical attention.

* Hazard risks outweigh the educational value. Districts are advised to make their own decisions. Consult MSDS for additional information.

▲ On the California Health and Welfare Agency list "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity." Districts are advised to weigh risks to employees.

TABLE 3 (Continued)

Name and NFPA Symbol	Label	Hazard	First Aid
Aluminum Metal 	Dangerous when wet. 1/2/3/FLAMMABLE (powder) 4.3	Easily ignited. May explode. Can have hazardous reactions with metal oxides.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
Aluminum Sulfate	10/1/3/Not regulated	No reaction with water. Readily hydrolyzes to form sulfuric acid. Dust/vapor may be harmful if inhaled. Ingestion in large doses causes gastric irritation, nausea, vomiting. May corrode metals in presence of moisture.	*External*—Irrigate exposed eyes and skin thoroughly for 15 minutes. *Internal*—Do not give emetic. Seek immediate medical attention.
Ammonium Carbonate	10/1/3/Not regulated	Evolves irritating fumes when heated.	*External*—Irrigate exposed eyes with water for 15 minutes. Seek medical attention. *Inhalation*—Move to fresh air. Seek medical attention. *Internal*—Do not give emetic. Seek medical attention.
Ammonium Chloride  Nonfire  Fire	10/1/1/Not regulated	Moderately toxic by ingestion. Fire may produce irritating or poisonous gas. Reacts violently with water. May spontaneously decompose.	*Internal*—Seek immediate medical attention.
Ammonium Hydroxide	WARNING! Corrosive. Liquid causes burns. Vapor extremely irritating. Avoid breathing vapor. Avoid contact with skin, eyes, and clothing. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. 4/1/3/CORROSIVE 8	Corrosive. Caustic inorganic base; gas and vapor toxic; strong eye, lung, and skin irritant. Edema of mucous membranes and lungs results from inhalation of high concentrations of gas.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. In the event of spillage, neutralize with vinegar or dilute acetic acid. *Internal*—Do not use emetics. Give water to dilute. Remove to fresh air. Seek immediate medical attention.

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* Hazard risks outweigh the educational value. Districts are advised to make their own decisions. Consult MSDS for additional information.

▲ On the California Health and Welfare Agency list "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity." Districts are advised to weigh risks to employees.

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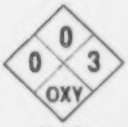
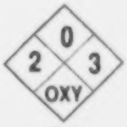
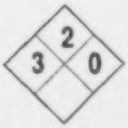
TABLE 3 (Continued)

Name and NFPA Symbol	Label	Hazard	First Aid
Ammonium Nitrate  Nonfire  Fire	Oxidizer. 3/1/2/OXIDIZER 5.1	Will decompose above 160°C (320°F). It produces explosive gaseous substances, especially when confined in a closed container. Oxidizer. Toxic by ingestion, inhalation, and skin contact. Eye and respiratory irritant.	If exposed to products of combustion, seek immediate medical attention. *External*—Irrigate eyes and skin for 15 minutes; for eyes, contact doctor. *Internal*—If conscious, induce vomiting; seek immediate medical attention.
Ammonium Persulfate	Oxidizer. 2/1/3/OXIDIZER 5.1	Strong oxidizer.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention.
▲Aniline 	DANGER! Hazardous liquid and vapor. Rapidly absorbed through skin. Do not get in eyes, on skin, or on clothing. Use only with adequate ventilation. Dispose of immediately. (See Table 2.) *Dispose of*/1/1/POISON 6.1	Suspected teratogen. Dangerous when inhaled, swallowed, or absorbed through skin contact. Flammable. May give off explosive vapors when heated.	*External*—Wash off skin promptly. Flush eyes with water for 20 minutes. In case of spill, promptly discard materials used to wipe up spills. *Internal*—Seek immediate medical attention.
*Antimony	DANGER! Causes severe burns. Vapor hazardous. Do not get in eyes, on skin, or on clothing. Do not breathe dust, mist, fumes, or vapor. Keep container closed. In case of contact, immediately remove all contaminated clothing and flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Wash clothing before reuse. 1/1/3/KEEP AWAY FROM FOOD	Highly toxic; a poison if swallowed, inhaled, or absorbed through the skin. Dust is eye irritant. Animal lung carcinogen. Incompatible with aluminum and acidic-reducing agents.	*External*—Wash eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Induce vomiting. Maintain respiration. Seek immediate medical attention.

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* Hazard risks outweigh the educational value. Districts are advised to make their own decisions. Consult MSDS for additional information.

▲ On the California Health and Welfare Agency list "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity." Districts are advised to weigh risks to employees.

TABLE 3 (Continued)

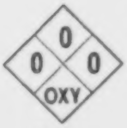
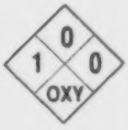
Name and NFPA Symbol	Label	Hazard	First Aid
Barium (soluble compounds)	WARNING! May be fatal if swallowed. Avoid inhalation of dust. Avoid contact. POISON. Keep away from food. 2/1/3/POISON 6.1	Extremely poisonous when inhaled, swallowed, or absorbed through skin contact.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Induce vomiting. Seek immediate medical attention.
Barium Chloride	WARNING! May be fatal if swallowed. Avoid inhalation of dust. POISON. Keep away from food. 10/1/3/POISON 6.1	Extremely toxic; ingestion can be fatal at concentrations of less than 0.8 mg.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Induce vomiting. Seek immediate medical attention.
Barium Hydroxide	WARNING! May be fatal if swallowed. Avoid inhalation of dust. POISON. Keep away from food. 10/1/1/POISON 6.1	Toxic by ingestion.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Induce vomiting. Seek immediate medical attention.
Barium Nitrate  Nonfire  Fire	WARNING! Oxidizer. Contact with combustible material may cause fire. POISON. May be fatal if swallowed. Keep container closed and away from combustible material and heat. Avoid contact with skin and eyes. Keep away from feed or food products. Sweep up and carefully remove spilled material. 2/1/3/OXIDIZER 5.1/ POISON 6.1	Toxic by ingestion.	*Internal*—Induce vomiting. Seek immediate medical attention.
Bismuth and alloys	1/1/3/Not regulated	Flammable in powder form. Wear goggles to avoid injury to eyes.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.

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TABLE 3 (Continued)

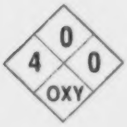
Name and NFPA Symbol	Label	Hazard	First Aid
Boric Acid	5/1/3/Not regulated	Ingestion by young children can cause severe vomiting, diarrhea, shock, and death. Inhalation is toxic. Skin irritant.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
*Bromine (ampule)  	DANGER! POISON. Corrosive. Causes severe burns. Vapor hazardous. Do not get in eyes, on skin, or on clothing. Do not breathe vapor. Wear goggles, neoprene rubber gloves, and rubber protective clothing when handling. In case of contact, immediately remove all contaminated clothing, including shoes, and flush skin with plenty of water for at least 15 minutes. Flush eyes for at least 30 minutes. Get medical attention in all cases. Wash clothing before reuse. If inhaled, remove patient to fresh air, keep warm and quiet until physician arrives. 8(ampule) or 2/1/3/ CORROSIVE 8/POISON 6.1 Best stored as an ampule.	Poisonous. Liquid causes severe skin burns. Exposure to high vapor concentrations could be deadly. Very strong oxidizer; reacts violently with many organic compounds; very hazardous even in small ampule. *Dispose of as extremely hazardous waste.*	*External*—Ventilate area. Sodium thiosulfate solution can be used as a neutralizer. Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
Butyl Alcohols: n-Butyl	CAUTION! Flammable liquid. Keep away from heat and open flame. Avoid prolonged breathing of vapor. Use with adequate ventilation. Avoid prolonged or repeated contact with skin. 7/1 or 2S/1/FLAMMABLE LIQUID 3	Flammable liquid. Prolonged inhalation can be toxic. Eye irritant. Absorbed by skin. Capable of forming explosive hydroperoxides.	*External*—Irrigate eyes with water. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.

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TABLE 3 (Continued)

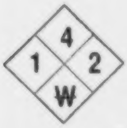
Name and NFPA Symbol	Label	Hazard	First Aid
tert-Butyl Alcohol	WARNING! Flammable liquid. Keep away from heat and open flame. Keep container closed. Use with adequate ventilation. Avoid prolonged breathing of vapor. Avoid prolonged or repeated contact with skin. 7/1 or 2S/1/FLAMMABLE LIQUID 3	Flammable liquid; "tert" is a flammable solid when in crystalline state. Prolonged inhalation can be toxic. Eye irritant. Absorbed by skin. Capable of forming explosive hydroperoxides.	*External*—Irrigate eyes with water. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
sec-Butyl Alcohol	CAUTION! Flammable liquid. Keep away from heat and open flame. Avoid prolonged breathing of vapor. Use with adequate ventilation. Avoid prolonged or repeated contact with skin. 7/1 or 2S/1/FLAMMABLE LIQUID 3	Flammable liquid. Prolonged inhalation can be toxic. Eye irritant. Absorbed by skin. Capable of forming explosive hydroperoxides.	*External*—Irrigate eyes with water. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
*Calcium Carbide 	(Tightly sealed) Dangerous when wet. 7/1 or 2/2/FLAMMABLE SOLID 4.3	Exposure to moisture produces explosive acetylene gas and corrosive solid. *Dispose of as extremely hazardous waste.*	*External*—Irrigate eyes with water. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
Calcium Chloride (anhydrous)	10/1/1/Not regulated	Acute ingestion may result in intestinal irritation and hemorrhage.	*External*—Wash with water. *Internal*—Seek immediate medical attention.
Calcium Chloride (dihydrate)	10/1/1/Not regulated	Irritant. Mucous membrane damage might occur.	*External*—Eyes should be flushed with water for 15 minutes. *Internal*—Maintain respiration. Seek immediate medical attention.

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TABLE 3 (Continued)

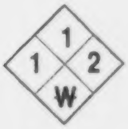
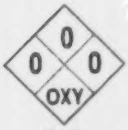
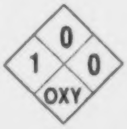
Name and NFPA Symbol	Label	Hazard	First Aid
Calcium Hydroxide	Avoid inhalation and skin contact. Use eye protection. 10/1/1/Not regulated	Inorganic base (caustic). Skin irritant. Avoid dust inhalation.	*External*—Irrigate eyes with water. If calcium hydroxide comes into contact with eyes, seek immediate medical attention. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
Calcium Hypochlorite	Oxidizer. 2/1/1/OXIDIZER 5.1	Poisonous. Corrosive powder. Harmful to eyes, lungs, and skin. Toxic by ingestion, inhalation, and skin contact. Oxidizer. Fire risk in contact with organic substances. Emits chlorine gas under certain conditions. *Dispose of as extremely hazardous waste.*	*External*—Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Seek immediate medical attention.
Calcium Metal 	Avoid contact with water. Store in tightly closed container. Avoid contact with oxidizers. Dangerous when wet. 7/1KM/2(in airtight conditions)/ DANGEROUS WHEN WET	Contact with water, acids, alkali, hydroxides, or carbonates may cause detonation. Burns in air. Dust and fumes are highly toxic. *Dispose of as extremely hazardous waste.*	*External*—Irrigate eyes with water for 15 minutes. If calcium contacts eyes, seek immediate medical attention. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
Calcium Nitrate  Nonfire  Fire	Oxidizer. 2/1/1/OXIDIZER 5.1	Strong oxidizer; potential fire risk with organic material. May explode if shocked or heated.	*Internal*—Induce vomiting and seek immediate medical attention.

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TABLE 3 (Continued)

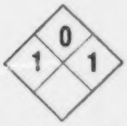
Name and NFPA Symbol	Label	Hazard	First Aid
Calcium Oxide (lime) 	Corrosive. Keep dry. 10/1 (polyethylene) keep dry/1/CORROSIVE 8	Strongly caustic. Dangerous when in contact with organic materials. May cause severe irritation of skin and mucous membrane. Exposure to water or moisture evolves heat. Wear eye protection.	*External*—Irrigate eyes with water. Wash skin with soap and water. *Internal*—Seek immediate medical attention.
Camphor	Flammable solid. 7/1/3/FLAMMABLE SOLID 4.1	Poisonous on ingestion. If heated, flammable and explosive vapors evolve. Moderately toxic. Absorbed through skin.	*Internal*—Induce vomiting. Seek immediate medical attention.
▲Cobalt Metal (powder)	1/1/3/Not regulated.	Moderately toxic by ingestion. Inhalation of dust may cause pulmonary damage. Ingestion of soluble salts produces nausea and vomiting by local irritation. Powder may cause dermatitis. Powdered cobalt ignites spontaneously in air; flammable when exposed to heat or flames.	*External*—Irrigate eyes with water for at least 15 minutes. Flush skin with water. Remove contaminated clothing and shoes. *Internal*—If inhaled, move victim to fresh air. If breathing has stopped, begin artificial respiration. If ingested, give large amounts of water and induce vomiting. If victim is unconscious or having convulsions, keep warm. Seek immediate medical attention.
Cobalt Chloride (hexahydrate)	Hygroscopic; keep tightly closed. 10/1/2/Not regulated	Moderately toxic by ingestion; causes pain, vomiting, diarrhea. Causes blood damage. Contact causes eye irritation and may cause skin rash. When heated to decomposition, emits toxic fumes of chloride.	*External*—Irrigate eyes with water for at least 15 minutes. Flush skin with water. Remove contaminated clothing and shoes. *Internal*—If inhaled, move victim to fresh air. If breathing has stopped, begin artificial respiration. If ingested, give large amounts of water and induce vomiting. If victim is unconscious or having convulsions, keep warm. Seek immediate medical attention.

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TABLE 3 (Continued)

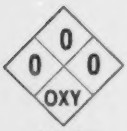
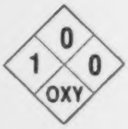
Name and NFPA Symbol	Label	Hazard	First Aid
Cobalt Sulfate	10/1/3/Not regulated	Poisonous by intravenous and intraperitoneal routes. Moderately toxic by ingestion—causes nausea and vomiting. Eye, skin, and respiratory irritant. Fine dust is flammable. When heated to decomposition, it emits toxic fumes of sulfur dioxide.	*External*—Irrigate eyes with water. If breathing has stopped, give artificial respiration; if breathing is difficult, give oxygen. Remove contaminated clothing and shoes. *Internal*—If swallowed and victim is conscious, give water and induce vomiting. If victim is unconscious or having convulsions, do nothing but keep victim warm. Seek immediate medical attention.
Cobalt Nitrate	Oxidizer. 2/1/3/OXIDIZER 5.1	Oxidizer. Fire risk in contact with organic materials. Poisonous by ingestion and by intramuscular and subcutaneous routes. An experimental tumorigen. Experimental reproductive effects. When heated to decomposition, it emits toxic fumes of nitric oxide.	*External*—Irrigate eyes with water for at least 15 minutes. Flush skin with water. Remove contaminated clothing and shoes. *Internal*—If inhaled and breathing is difficult, give oxygen. If breathing has stopped, give artificial respiration. If swallowed and victim is conscious, give water and induce vomiting. If victim is unconscious or having convulsions, do nothing except keep victim warm. Seek immediate medical attention.
Cupric Chloride	Corrosive 10/1 or 2/1/CORROSIVE 8	Toxic by ingestion and inhalation	*External*—Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Seek immediate medical attention. Maintain respiration.
Cupric Nitrate  Nonfire  Fire	Oxidizer. 2/1 or 2/1/OXIDIZER 5.1	Oxidizing material. Dangerous in contact with organic materials. Moderately toxic.	*External*—Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Seek immediate medical attention. Maintain respiration.

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TABLE 3 (Continued)

Name and NFPA Symbol	Label	Hazard	First Aid
Cupric Oxide	10/1 or 2/3/Not regulated	Toxic by ingestion. Irritant to skin, eyes, and mucous membrane. Copper material may cause allergic reaction.	*External*—Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Seek immediate medical attention. Maintain respiration.
Cupric Sulfate	10/1 or 2/2/Not regulated	Toxic by ingestion. Irritant to skin, eyes, and mucous membrane. Copper material may cause allergic reaction.	*External*—Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Seek immediate medical attention. Maintain respiration.
Cyclohexane	DANGER! Extremely flammable liquid. Keep away from heat, sparks, and open flame. Keep container closed. Use with adequate ventilation. Avoid prolonged breathing of vapor. 7/1 or 2S/3/FLAMMABLE LIQUID 3	Flammable; vapor and liquid harmful to eyes, lungs, and skin.	*External*—Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Do not induce vomiting. Seek immediate medical attention.
*Ethidium Bromide	Potent mutagen. Do not breathe. Solution is sensitive to light. (See special use/handling practices on page 25.) Keep in original container in locked cabinet. 8/2/2/Not regulated	May be harmful by inhalation, ingestion, or skin absorption. Irritating to mucous membranes, skin, and upper respiratory tract. *Potent mutagen*—will damage human genetic material. Do not breathe dust. Do not get in eyes, on skin or clothing. Wash contaminated clothing before reuse. Use in a chemical fume hood. Toxic fumes under fire conditions. (See page 25.)	*External*—Immediately flush eyes with copious amounts of water for at least 15 minutes. Wash skin with soap and copious amounts of water. Remove contaminated clothing/shoes immediately. *Internal*—If inhaled, remove to fresh air. Maintain respiration; if breathing difficult, give oxygen. Keep person warm and at rest. Seek immediate medical attention.

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TABLE 3 (Continued)

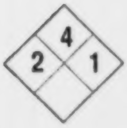
Name and NFPA Symbol	Label	Hazard	First Aid
Ethyl Acetate	WARNING! Flammable. Keep away from heat and open flame. Keep container closed. Use with adequate ventilation. Avoid prolonged breathing of vapor. Avoid prolonged or repeated contact with skin. 7/1/2/FLAMMABLE LIQUID 3	Fire hazard and explosion risk. Irritating to skin and eyes.	*External*—Remove victim to fresh air. Irrigate eyes with water. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
Ethyl Alcohol	Flammable liquid. 7/2 or 2S/3/FLAMMABLE LIQUID 3	Poison. Vapor toxic. Fire hazard. Denatured alcohol may cause blindness or death if taken internally. Reproductive toxin when taken in alcoholic beverages.	*External*—Wash affected parts with copious quantities of water. *Internal*—Wash mouth. See a physician.
Ethyl Ether/Diethyl Ether 	DANGER! Extremely flammable liquid. Highly volatile. (See Table 1.) Tends to form explosive peroxides, especially when anhydrous. Keep away from heat, sparks, and open flame. Keep container tightly closed. Do not allow to evaporate to near dryness. Addition of water or appropriate reducing agents will lessen peroxide formation. *Dispose of before 12 months old.* 7/2S or PVC-coated bottles/1/ FLAMMABLE LIQUID 3	Flammable, light-sensitive. During storage most ethers are subject to the formation of ether peroxides, which make ether highly explosive. If stored more than 12 months, dispose of by calling bomb squad.	*External*—Ventilate area. Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Seek immediate medical attention.
Ferric Chloride	Corrosive. 10/1/1/CORROSIVE 8	Skin and tissue irritant; corrosive.	*External*—Irrigate eyes and skin with water for 15 minutes. Seek medical attention. *Internal*—Give emetic, seek medical attention.

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TABLE 3 (Continued)

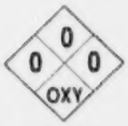
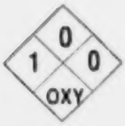
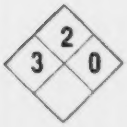
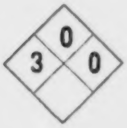
Name and NFPA Symbol	Label	Hazard	First Aid
Ferric Nitrate  Nonfire  Fire	Oxidizer. 2/1/1/OXIDIZER 5.1	Strong oxidizer. Contact with organic material may cause fire. Skin and tissue irritant.	Wash thoroughly after handling.
Ferrous Sulfate	10/1/1/Not regulated	Toxic by ingestion.	*Internal*—Give emetic unless solution is very acid. Seek immediate medical attention.
Formic Acid 	WARNING! Corrosive. Causes burns. Avoid contact with skin and eyes. Avoid breathing vapor. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. 5/1/1/CORROSIVE 8	Toxic compound. Concentrated form is unstable and subject to explosion. Painful wounds on contact with skin.	*External*—Irrigate eyes with water for 15 minutes Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention.
Hexane	Flammable liquid. 7/1 or 2S/3/FLAMMABLE LIQUID 3	Flammable. May be irritating to respiratory tract and narcotic in high concentrations. Repeated overexposure to n-hexane can cause peripheral nerve damage.	*External*—Ventilate area. Irrigate eyes with water for 15 minutes. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
Hydrochloric Acid 	WARNING! Causes burns. Avoid contact with skin and eyes. Avoid breathing vapor. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. 5/1/2/CORROSIVE 8	This chemical is dangerous when inhaled, swallowed, or absorbed through skin contact. Corrosive solution and fumes. *Warning*—causes burns. *Dispose of as extremely hazardous waste.*	*External*—In case of contact, immediately flush skin or eyes with large amounts of water for at least 15 minutes; for eyes, get medical attention immediately. *Internal*—If ingested, seek immediate medical attention.
Hydrogen Peroxide (3%)	10/1/1/Not regulated	Avoid contact with eyes. Do not heat this substance.	*External*—Rinse with water soon after contact.

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TABLE 3 (Continued)

Name and NFPA Symbol	Label	Hazard	First Aid
*Hydrogen Peroxide (35%)	CAUTION! Oxidizer. Corrosive. Strong oxidant. Avoid contact with skin and eyes. Wear rubber gloves and goggles. Avoid contact with combustible materials. Drying of this concentrated product on clothes or other combustible materials may cause fire. In case of contact, immediately flush with plenty of water for at least 15 minutes; for eyes, get medical attention. Remove and wash clothing at once. Avoid contamination from any source, including metals, dust, etc. Such contamination may cause rapid decomposition, generation of large quantities of oxygen gas, and high pressures. Store in original, closed container. Be sure that the container vent is working satisfactorily. Do not add any other product to this container. When empty, rinse thoroughly with clean water. 2/1 vented cap or accordion bottle/1/OXIDIZER 5.1/ CORROSIVE 8	Strong oxidant; avoid contact with combustible materials. High concentrations can cause burns to the eyes, lungs, and skin. Do not heat this substance. Store in original container.	*External*—Flush with water. Use burn ointment. Seek medical attention. Remove and wash contaminated clothing promptly and thoroughly.
Iodine	2/1/2/Not regulated	Inhalation of vapors or ingestion may be fatal. Vapor corrosive to eyes and respiratory tract. Solid stains the eyes and skin. Stain is poisonous. Reacts violently with reducing materials, sulfur, iron, alkali metals, metal powders, and phosphorous.	*External*—Remove iodine stains by washing first with a sodium thiosulfate solution and then with water. Flush eyes with large amounts of water. *Internal*—Seek immediate medical attention.

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TABLE 3 (Continued)

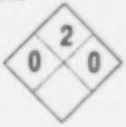
Name and NFPA Symbol	Label	Hazard	First Aid
Isobutyl Alcohol	Flammable liquid. 7/1 or 2S/3/FLAMMABLE LIQUID 3	Flammable. Mildly irritating to skin, eyes, and mucous membranes. Mildly toxic.	*External*—Rinse eyes with water. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
Isopropyl Alcohol	Flammable liquid. 7/1 or 2S/1/FLAMMABLE LIQUID 3	Flammable. Toxic by ingestion and inhalation.	*External*—Eye irritant. Irrigate eyes with water. *Internal*—Seek medical attention.
Kerosene 	Flammable liquid. 7/1 or 2S/3/FLAMMABLE LIQUID 3	Flammable. Irritating to skin. Can cause infection. High concentrations of vapors are toxic.	*External*—Wash skin with soap and water. *Internal*—Do not give emetics. Seek immediate medical attention.
▲ Lead	Avoid breathing dust. 1/2/3/POISON/Not regulated	Toxic; poison is cumulative. Dust very harmful to kidneys, blood, and nervous system. Harms male and female reproductive systems and the developing fetus. Known carcinogen.	*External*—Wash skin with water. Seek immediate medical attention.
▲ Lead Carbonate	Avoid breathing dust. 10/1/3/Not regulated	Toxic by inhalation and ingestion. Skin, eye, and respiratory irritant. Known carcinogen. Reproductive toxin.	*Inhalation*—Move to fresh air. If breathing has stopped, give artificial respiration. Seek immediate medical attention. *Internal*—Induce vomiting. Seek immediate medical attention. *External*—Irrigate skin/eyes with water. Seek immediate medical attention.
▲ Lead Chloride	Avoid breathing dust. 10/1/3/Not regulated	Toxic by inhalation and ingestion. Known carcinogen. Reproductive toxin.	*Inhalation*—Move to fresh air. If breathing has stopped, give artificial respiration. Seek immediate medical attention. *Internal*—Induce vomiting. Seek immediate medical attention. *External*—Irrigate skin/eyes with water. Seek immediate medical attention.

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TABLE 3 (Continued)

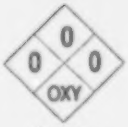
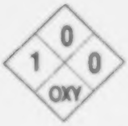
Name and NFPA Symbol	Label	Hazard	First Aid
▲ Lead Nitrate  Nonfire  Fire	Oxidizer. POISON. 2/1/3/OXIDIZER 5.1/ POISON	Toxic by inhalation and ingestion. Serious fire risk in contact with organic material. Known carcinogen. Reproductive toxin.	*Inhalation*—Move to fresh air. If breathing has stopped, give artificial respiration. Seek immediate medical attention. *Internal*—Induce vomiting. Seek immediate medical attention. *External*—Irrigate skin and eyes with water. Seek immediate medical attention.
▲ Lead Oxide	WARNING! Harmful dust. Avoid breathing dust. Wear dust mask approved by U.S. Bureau of Mines for this purpose. Wash thoroughly before eating or smoking. Keep away from food or food products. 10/1/3/Not regulated	Toxic by ingestion and inhalation. Known carcinogen. Reproductive toxin.	*Inhalation*—Move to fresh air. If breathing has stopped, give artificial respiration. Seek immediate medical attention. *Internal*—Induce vomiting. Seek immediate medical attention. *External*—Irrigate skin and eyes with water. Seek immediate medical attention.
▲ Lead Peroxide (dioxide)	Oxidizer. Avoid breathing dust. 2/1/3/OXIDIZER 5.1	Toxic by inhalation and ingestion. Dangerous fire risk in contact with organic material. Known carcinogen. Reproductive toxin.	*Inhalation*—Move to fresh air. If breathing has stopped, give artificial respiration. Seek immediate medical attention. *Internal*—Induce vomiting. Seek immediate medical attention. *External*—Irrigate skin and eyes with water. Seek immediate medical attention.
▲ Lead Sulfate	Corrosive. Avoid breathing dust. 10/1/3/CORROSIVE 8	Toxic; serious skin irritant. Known carcinogen. Reproductive toxin.	*Inhalation*—Move to fresh air. If breathing has stopped, give artificial respiration. Seek immediate medical attention. *Internal*—Induce vomiting. Seek immediate medical attention. *External*—Irrigate skin and eyes with water. Seek immediate medical attention.

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TABLE 3 (Continued)

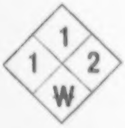
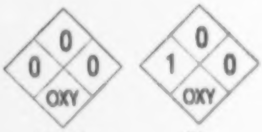
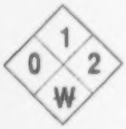
Name and NFPA Symbol	Label	Hazard	First Aid
▲ Lead Sulfide	Avoid breathing dust. 10/1/3/Not regulated	Toxic by ingestion and inhalation. Known carcinogen. Reproductive toxin.	*Inhalation*—Move to fresh air. If breathing has stopped, give artificial respiration. Seek immediate medical attention. *Internal*—Induce vomiting. Seek immediate medical attention. *External*—Irrigate skin and eyes with water. Seek immediate medical attention.
Lithium 	Dangerous water reactive; explosion risk. Use a class D fire extinguisher. Dangerous when wet. 1/1KM/3/FLAMMABLE 4.3	Causes severe burns on contact with skin, eyes, or lungs. Ignites spontaneously in moist air; highly flammable. Compounds toxic if swallowed; avoid inhalation of dust and skin contact. *Dispose of as extremely hazardous waste.*	*External*—Flush with water. Seek immediate medical attention.
Lithium Nitrate  Nonfire Fire	Oxidizer. 2/1/3/OXIDIZER 5.1	Risk of explosion when shocked or heated. Strong oxidant.	*Internal*—Induce vomiting unless patient is comatose or convulsing or has lost gag reflex.
Magnesium Chloride	10/1/1/Not regulated	Moderately toxic by ingestion. Dusts may be irritating. Overexposure causes nausea and vomiting.	*Internal*—Induce vomiting and seek immediate medical attention.
Magnesium Metal (powder/ribbon) 	Flammable solid. 1/2/3/FLAMMABLE 4.1	Dangerous in powder form because of fire potential. Magnesium burns are often severe and may be slow to heal. *Dispose of as extremely hazardous waste.*	*External*—In case of burns, seek immediate medical attention.

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TABLE 3 (Continued)

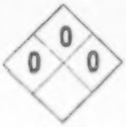
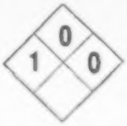
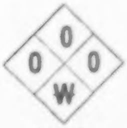
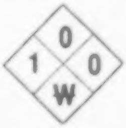
Name and NFPA Symbol	Label	Hazard	First Aid
Magnesium Nitrate  Nonfire  Fire	Oxidizer 2/1/1/OXIDIZER 5.1	Strong oxidant. Fire and explosion risk in contact with organic material. Skin, eye, and respiratory tract irritant.	*External, Internal, Inhalation*—Seek immediate medical attention.
Magnesium Oxide	10/1/1/Not regulated	Dust toxic by inhalation.	*External, Internal, Inhalation*—Seek immediate medical attention.
Magnesium Sulfate (Epsom salts)	10/1/1/Not regulated	Irritates eyes and respiratory tract.	*External*—Flush eyes with water for 15 minutes. *Inhalation*—Move to fresh air; seek medical attention.
Manganese Dioxide	2/1/3/Not regulated	Strong oxidizer, moderately toxic. Avoid contact with organic material	*External*—Wash skin with soap and water.
Manganous Sulfate	10/1/1/Not regulated	Tissue irritant.	*External*—Induce vomiting and seek immediate medical attention.
▲ Mercurous/Mercuric Nitrate  Nonfire  Fire	POISON. 2/1/1/POISON 6.1	Same as mercury compounds. Also is a fire hazard with organic compounds.	*External*—See treatment under mercury metal. *Internal*—Do not give emetic if solution'is acidic.
▲ Mercury Compounds	DANGER! Highly toxic. May be fatal if swallowed. Do not breathe dust. Keep away from feed or food products. Wash thoroughly after handling. POISON 8/1/2/POISON 6.1	All are considered poisonous and harmful by swallowing, inhaling, or absorbing through the skin. Vapor, dust, solutions, and solids are all to be handled with caution. Can cause damage to kidneys and nervous system. Suspected teratogen. Fire hazard with organic materials. *Dispose of as extremely hazardous waste.*	*External*—See treatment under mercury metal. *Internal*—Seek immediate medical attention.

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TABLE 3 (Continued)

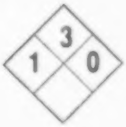
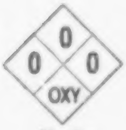
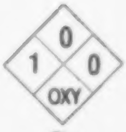
Name and NFPA Symbol	Label	Hazard	First Aid
▲ Mercury Metal	WARNING! Vapor harmful. Avoid breathing vapor. Corrosive. (Keep only small quantities in locked cabinet.) 8/1/2/CORROSIVE 8	Both vapor and liquid are poisonous. Contact with skin should be avoided because absorption and continuous exposure to vapor can be harmful. Suspected teratogen. Can cause damage to kidneys and nervous system. *Dispose of as extremely hazardous waste.*	*External*—No specific treatment for mercury poisoning except the administering of chelating agents to speed the elimination of mercury from the body. Wash skin with soap and water. *Internal*—Induce vomiting unless person is comatose, convulsing, or has lost gag reflex.
Methanol 	DANGER! Flammable liquid. POISON. Vapor harmful. May be fatal if swallowed. Cannot be made nonpoisonous. 7/1 (glass only) or 2S/2/ FLAMMABLE LIQUID 3	Flammable; poisoning may occur from ingestion, inhalation, or absorption through the skin. Can be lethal. Can cause blindness, metabolic acidosis.	*External*—Ventilate area. Irrigate eyes with water. Wash skin with soap and water. *Internal*—If swallowed, give a teaspoon of salt in a glass of warm water; repeat until vomit fluid is clear. Give two teaspoons of baking soda in a glass of water. Have patient lie down and keep warm. Cover eyes to exclude light. Seek immediate medical attention.
Methyl Cellulose	7/1/3(in solution)/Not regulated		
Methyl Ethyl Ketone	WARNING! Flammable liquid. Keep away from heat and open flame. Keep container closed; use with adequate ventilation. Avoid prolonged breathing of vapor. Avoid prolonged or repeated contact with skin. 7/1 or 2/2/FLAMMABLE LIQUID 3	Flammable. Dangerous fire risk. Narcotic by inhalation.	*External*—Wash with soap and water and seek medical attention. *Internal*—Seek immediate medical attention. *Inhalation*—Move to fresh air. Seek immediate medical attention.
▲ Nickel Nitrate  Nonfire  Fire	Oxidizer. POISON. Avoid body contact. Avoid inhaling dust. Avoid contact with organic materials. (See Table 2.) *Dispose of*/1/1/OXIDIZER 5.1	Known carcinogen. Toxic as dust or fumes. Dangerous fire risk.	*External*—Flush with water. Irrigate eyes with water for 15 minutes. Seek medical attention. *Internal*—Wash mouth. Seek medical attention.

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TABLE 3 (Continued)

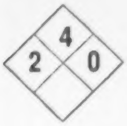
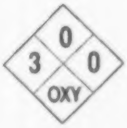
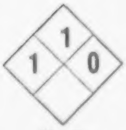
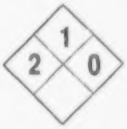
Name and NFPA Symbol	Label	Hazard	First Aid
▲ Nickel Powder 	Keep away from skin, eyes, and mucous membranes. Keep away from acids and oxidizing agents. (See Table 2.) *Dispose of*/1/3/Not regulated	Known carcinogen. Toxic as dust or fumes. Flammable as dust or fumes.	*External*—Flush with water. Irrigate eyes with water for 15 minutes. Seek medical attention. *Internal*—Wash mouth. Seek medical attention.
▲ Nicotine	POISON. 8/1/1/POISON 6.1	Toxic in contact with skin. If swallowed, can be fatal. Teratogen. Handle only in salt form when extracting from tobacco.	*External*—Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention.
Nitric Acid 	DANGER! Causes severe burns. Do not breathe vapor. Vapor extremely hazardous; may cause nitrous gas poisoning. Avoid contact with skin, eyes, and clothing. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Spillage may cause fire or liberate dangerous gas. Dilute: <50% corrosive. Concentrated: >50% corrosive, oxidizer. 6/1/2/CORROSIVE 8/ OXIDIZER	Severe skin burns. Tissue damage if swallowed. Dental erosion; nasal and lung irritant.	*External*—Flush with water for 15 minutes. *Internal*—Maintain respiration. Seek immediate medical attention.
Oxalic Acid  Nonfire  Fire	WARNING! Harmful if swallowed. Causes skin irritation. Avoid breathing dust. Avoid contact with skin and eyes. Do not take internally. Keep away from feed or food products. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. 10/1/3/POISON 6.1	Dangerous when inhaled, swallowed, or absorbed through skin contact.	*External*—Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention.

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TABLE 3 (Continued)

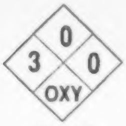
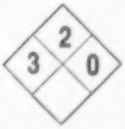
Name and NFPA Symbol	Label	Hazard	First Aid
Oxygen Gas  (Liquid)	Store away from any source of heat or flame. Nonflammable gas. Oxidizer. 9a/cylinder/3/ NONFLAMMABLE GAS 2.2, OXIDIZER	Supports combustion.	
Paraffin Wax	10/original container/3/ Not regulated	Flammable. Toxic.	*Internal*—For inhalation of fumes, remove to fresh air. Maintain respiration. Seek medical attention.
Pentane	Flammable liquid. 7/1(glass only) or 2S/3/ FLAMMABLE LIQUID 3	Flammable. Toxic. Narcotic in high concentrations.	*External*—Ventilate area. Irrigate eyes with water. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
Petroleum Ether	Flammable liquid. 7/1(glass only) or 2S/3/ FLAMMABLE LIQUID 3	Flammable.	*External*—Ventilate area. Irrigate eyes with water. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.
*Phenol (carbolic acid) 	DANGER! POISON. Rapidly absorbed through skin. Causes severe burns. Do not get in eyes, on skin, or on clothing. Avoid breathing vapor. Do not take internally. In case of contact, immediately remove all contaminated clothing, including shoes, and flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Wash clothing before reuse. 8/1/1POISON 6.1	Severe burn and tissue damage; toxic by ingestion, inhalation, and skin absorption. Phenol in contact with more than 100 square inches of skin (10"x10") is absorbed so quickly through the skin that it is fatal in 90 seconds—unless quickly washed off with copious amounts of water.	*External*—Wash with water; then neutralize with sodium bicarbonate. Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention.

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TABLE 3 (Continued)

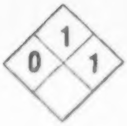
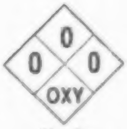
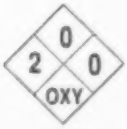
Name and NFPA Symbol	Label	Hazard	First Aid
* Phosphorus (red)  	Flammable solid. 1/2/1/FLAMMABLE SOLID 4.1	Yields very toxic fumes on burning. Avoid contact with oxidizers. Explosions have been known to result. Dangerous fire risk; skin contact may cause burns.	*External*—Flush with water for 15 minutes. Treat splattered phosphorus with 2% solution of copper sulfate and keep area wet until medical attention is obtained. Seek immediate medical attention. *Internal*—Force vomiting immediately. Seek immediate medical attention. Do not administer alcohol, digestible fats, oil, or mineral oil as they enhance absorption.
Potassium Bromide	10/1/2/Not regulated	Toxic by ingestion and inhalation.	*Internal*—Induce vomiting and seek immediate medical attention. *Inhalation*—Move to fresh air.
*Potassium Chlorate  Nonfire  Fire	WARNING! Oxidizer. Contact with combustible material may cause fire. Will explode with shock or heat if only slightly contaminated. All clothing contaminated with chlorates is dangerously flammable. Remove and wash thoroughly with water. Do not get on floor. Spillage may cause fires with combustible material. Sweep and remove immediately. When not in use, keep tightly closed in original metal container. Keep away from fire. Store separately from flammable material. 2/1 or 2/3/OXIDIZER 5.1	Explodes easily (with shock or heat). Poisonous dust is irritant to lungs; harmful to skin and eyes. Reacts explosively with hydrocarbons, such as kerosene. Detonates if ground with mortar and pestle. Use large rubber stopper to grind. Do not grind with other substances.	*External*—Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention.
Potassium Chloride	8/1/1/Not regulated		*Internal*—Induce vomiting and seek immediate medical attention.

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TABLE 3 (Continued)

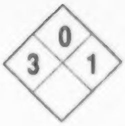
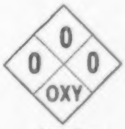
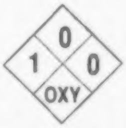
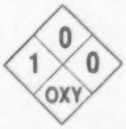
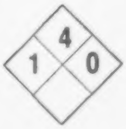
Name and NFPA Symbol	Label	Hazard	First Aid
Potassium Hydroxide 	WARNING! Corrosive. Causes severe burns to skin and eyes. Avoid contact with skin, eyes, and clothing. Do not take internally. When handling, wear goggles or face shield. When making solutions, add potassium hydroxide slowly to surface of solution to avoid violent splattering. In case of contact, immediately flush skin with plenty of water and wash with vinegar; for eyes, flush with plenty of water for at least 15 minutes and get medical attention. 4/1/3/CORROSIVE 8	Caustic. Corrosive as a solid and in solution.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water; neutralize with vinegar. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention.
Potassium Iodide	10/1/1/Not regulated	Low toxicity. Decomposition releases toxic fumes.	*Internal*—Induce vomiting and seek immediate medical attention.
Potassium Nitrate  Nonfire  Fire	Oxidizer. 2/1/2/OXIDIZER 5.1	Dangerous fire hazard and explosion risk when shocked or heated in contact with organic materials. Skin irritant.	*Internal*—Induce vomiting and seek immediate medical attention.
Potassium Permanganate 	Wear face protection. Oxidizer. 2/1/3/OXIDIZER 5.1	Strong skin irritant. Explosion may occur if brought in contact with organic or other readily oxidizable substances or if heated suddenly.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention.
Propane 	Flammable gas. 9b/cylinder/3/ FLAMMABLE GAS 2.1	Flammable. Narcotic in high concentrations.	*External*—Ventilate area.

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TABLE 3 (Continued)

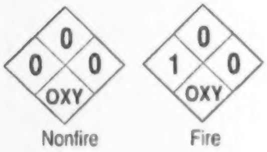
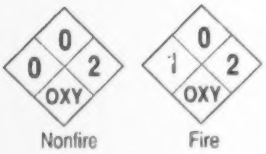
Name and NFPA Symbol	Label	Hazard	First Aid
Resorcinol	Keep away from food. 10/1/3/POISON 6.1	Irritating to skin, eyes, and mucous membranes. Toxic.	*External*—Irrigate eyes with water. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention.
Silver Nitrate 	WARNING! Oxidizer. May cause burns. Avoid contact with skin and eyes. In case of contact with eyes, flush with water for at least 15 minutes and get medical attention. 2/1 amber glass/3/ OXIDIZER 5.1	Silver nitrate causes caustic, poisonous burns. Skin irritant. Keep away from eyes.	*External*—Wash skin with water. Immediate treatment with sodium thiosulfate will prevent black stains from forming. *Internal*—Give emetics, such as salt water. Seek immediate medical attention.
Sodium Chlorate 	WARNING! Oxidizer. Contact with combustible materials may cause fire. All clothing contaminated with chlorates is dangerously flammable. Remove and wash thoroughly with water. Do not get on floor. Spillage may cause fires with combustible material. Sweep up and remove immediately. When not in use, keep tightly closed in original metal container. Keep away from fire. Store away from flammable material. 2/2/3/OXIDIZER 5.1	Keep away from organic matter or other oxidizable substances. May explode if heated with organic matter. Toxic.	*External*—Irrigate eyes with water. Wash skin with soap and water. *Internal*—Maintain respiration. Seek immediate medical attention.

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TABLE 3 (Continued)

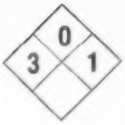
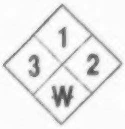
Name and NFPA Symbol	Label	Hazard	First Aid
Sodium Hydroxide  	WARNING! Corrosive. Causes severe burns to skin and eyes. Avoid contact with skin, eyes, and clothing. Do not take internally. When handling, wear goggles or face shield. When making solutions, add sodium hydroxide slowly to surface of solution to avoid violent splattering. In case of contact, immediately flush skin with plenty of water and wash with vinegar; for eyes, flush with plenty of water for at least 15 minutes and get medical attention. 4/1/2/CORROSIVE 8	Caustic, hazardous liquid. Eye and skin irritant. Inorganic bases can form explosive peroxides.	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water; neutralize with vinegar. *Internal*—If ingested, DO NOT induce vomiting. Seek immediate medical attention.
Sodium Hypochlorite (less than 7% chlorine)	Corrosive. 2/1/2/Corrosive/Not regulated	Caustic, poisonous, irritating to the skin and readily gives up chlorine. Inhalation may produce severe bronchial irritation. Evolves chlorine gas when reacted with acid or heated. Avoid contact with organic material. *Dispose of as extremely hazardous waste.*	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention. DO NOT induce vomiting.
Sodium Metal  	DANGER! Reacts violently with water, liberating and igniting hydrogen. May cause burns. Keep from any possible contact with water; store under oil. Keep container tightly closed. Do not get in eyes or on skin. Wear goggles and dry gloves when handling. In case of fire, smother with dry soda ash—never use water or chemical fire extinguishers. Dangerous when wet. 1/1KM/2/FLAMMABLE 4.3/ *WATER REACTIVE*	Flammable, corrosive solid. Reacts violently with water, causing fires and explosions and producing hydrogen gas and corrosive sodium hydroxide. *Dispose of as extremely hazardous waste.*	*Skin*—Remove sodium and flush affected area with water. *Eyes*—Immediately flush eyes with plenty of water for 15 minutes. Get medical attention.

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TABLE 3 (Continued)

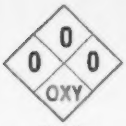
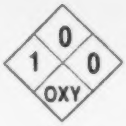
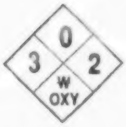
Name and NFPA Symbol	Label	Hazard	First Aid
Sodium Nitrate  Nonfire  Fire	Oxidizer. 2/1/3/OXIDIZER 5.1	Can be explosive if heated to 1000°F (537°C); can be detonated by shock or friction. Toxic by ingestion.	*Internal*—Induce vomiting and seek immediate medical attention.
Sodium Peroxide 	WARNING! Strong oxidant. Causes severe burns to skin and eyes. Wear goggles or face shield when handling. Avoid spillage. Avoid any contact with skin or clothing. Sweep up spilled material with dry sand and flood with water in the open. Keep container tightly closed at all times. Store in a cool, dry location away from acids or combustible materials. Dissolve carefully; always add the sodium peroxide to the liquid. Avoid contact with any combustible matter. In case of fire, smother with dry sand. Use a dry powder fire extinguisher (for class D fires). Never use a chemical fire extinguisher (i.e., those used for A, B, or C class fires). Do not use water unless fire continues; then flood with large quantities from a hose. 2/2/2/OXIDIZER 5.1	Absorbs water from the air. Ignition and explosion may take place on contact with organic matter, water, alcohol, acids, metallic or nonmetallic dust. Irritant and corrosive. *Dispose of as extremely hazardous waste.*	*External*—Irrigate eyes with water for 15 minutes. Wash skin with soap and water. Seek immediate medical attention. *Internal*—Maintain respiration. Seek immediate medical attention.
Sodium Silicate	10/2/3/Not regulated	Irritating; caustic to skin and mucous membranes.	*External*—Wash with water for 15 minutes. *Internal*—Give water and induce vomiting. Seek medical attention.

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TABLE 3 (Continued)

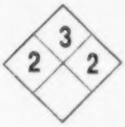
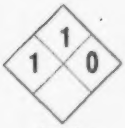
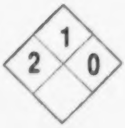
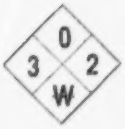
Name and NFPA Symbol	Label	Hazard	First Aid
Sodium Thiosulfate	10/1/1/Not regulated	Moderately toxic. Saturated solution breaks containers when crystalizing. May cause container to explode.	*External*—Wash skin and eyes with water for 15 minutes. *Internal*—Give water and induce vomiting. Seek medical attention.
Styrene 	CAUTION! Vapor harmful. Flammable liquid. Keep away from heat and open flame. Use only with adequate ventilation. Avoid prolonged breathing of vapor. Avoid prolonged or repeated contact with skin. 7/2S/1/FLAMMABLE LIQUID 3	Flammable. Irritating to eyes, nose, throat, and lungs. Extreme overexposure results in pulmonary edema. Frequent or prolonged skin contact can cause irritation and dermatitis. Can temporarily impair nervous system. Causes liver and kidney damage in animals. Known to cause damage to human genetic material.	*External*—Flush eyes with water for 15 minutes. Wash skin with soap and water. *Inhalation*—Remove to fresh air. Avoid prolonged breathing. Seek medical attention. Maintain respiration. *Internal*—DO NOT induce vomiting. Seek medical attention.
Sulfur  Nonfire  Fire	10/2/3/CLASS 9	Combustible; may be irritating to skin and mucous membranes; when burned, produces sulfur dioxide, a toxic gas which causes choking, coughing, chest pain, irritation to eyes and throat and can cause death at exposure levels of 500 ppm or greater.	*External*—Flush eyes with water. Wash skin with soap and water. Remove persons who show allergic reactions.
Sulfuric Acid 	DANGER! Causes severe burns. Do not get in eyes, on skin, or on clothing. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes; for eyes, get medical attention. Do not add water to contents while in a container because of violent reaction. 5/1/2 under dry conditions/ CORROSIVE 8	Dangerously corrosive chemical; hazardous liquid; eye, skin, and respiratory tract irritant. Absorbs water with violent reaction and emits heat.	*External*—Flush eyes with water. Wash skin with soap and water. *Internal*—DO NOT induce vomiting. Maintain respiration. Seek immediate medical attention.

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TABLE 3 (Continued)

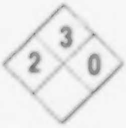
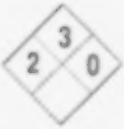
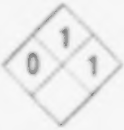
Name and NFPA Symbol	Label	Hazard	First Aid
▲ Toluene  	WARNING! Flammable. Vapor harmful. Keep away from heat and open flame. Keep container closed. Use only with adequate ventilation. Avoid prolonged breathing of vapor. Avoid prolonged or repeated contact with skin. 7/1 or 2S/2/FLAMMABLE 3	Poisonous and flammable liquid. Central nervous system depressant. Skin, eyes, nose, throat irritant. Exposure at high levels can irritate lungs. Inhalation during pregnancy may cause birth defects.	*External*—An exposed person should be removed immediately to fresh air and kept warm and quiet. Seek medical attention. Flush eyes with water.
1,1,2-Trichloro-1,2,2-trifluorethane (TTE) (Being phased out)	10/1/3/Not regulated	High concentration can lead to asphyxiation. May be body tissue irritant. Is a central nervous system depressant.	*External*—Irrigate skin and eyes with water. *Inhalation*—Move to fresh air. Seek immediate medical help.
Turpentine	Flammable liquid. 7/2S/3/FLAMMABLE LIQUID 3	Flammable liquid. Mild cause of allergy; toxic. Irritating to skin and mucous membranes.	*External*—Ventilate area. *Internal*—DO NOT induce vomiting. Seek immediate medical attention.
Xylene  	WARNING! Flammable. Keep away from heat and open flame. Keep container closed. Use with adequate ventilation. Avoid prolonged breathing of vapor. Avoid prolonged or repeated contact with skin. 7/2S/2/FLAMMABLE LIQUID 3	Flammable liquid. May impair nervous system. Irritating to eyes, nose, throat, skin, and lungs. Will penetrate most types of clothing. Extreme overexposure can cause pulmonary edema.	*External*—Irrigate eyes with water. Wash skin with soap and water. *Internal*—Seek medical attention.
Zinc, Metal Powder  	KEEP DRY! Dangerous when wet. Spontaneously combustible. 1/1/3 if kept dry/ FLAMMABLE SOLID 4.3	Dust is combustible. Irritating to skin and mucous membranes.	*External*—Irrigate eyes with water. Wash skin with soap and water. *Internal*—Seek medical attention.

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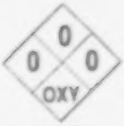
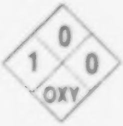
TABLE 3 (Continued)

Name and NFPA Symbol	Label	Hazard	First Aid
Zinc Nitrate  Nonfire  Fire	Oxidizer. 2/1/3/OXIDIZER 5.1	Moderately toxic. Strong oxidant; fire risk. Delayed eye irritant.	*External*—Irrigate eyes for 15 minutes and seek medical attention. *Internal*—Do not induce vomiting. *Inhalation*—Move to fresh air and seek immediate medical attention.

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H Substances Containing Asbestos

Asbestos-covered wire-gauze heating pads are no longer available commercially and should not be used in schools. Newer materials, such as ceramic, silica-base, or synthetic fibers, are now used to coat wire gauze and other laboratory heat-resistant equipment. The newer materials generally have better heat-resistant qualities than those of asbestos and are less subject to chemical damage. After use, the new materials often look like asbestos. Therefore, permanent marking, such as wires or staples on the edge, is recommended to identify the material.

Asbestos gloves or other soft or crumbly materials should be removed for disposal. *Asbestos is a recognized carcinogen. Asbestos fibers enter the body by inhalation. Avoid any use of asbestos.*

I Use and Disposal of Ethers

The use of ethers for instructional purposes can present a danger to students and school staff members. The most common types of ethers used in high schools are petroleum ether and diethyl ether (anesthetic ether). Petroleum ether is not a true ether (and does not produce peroxides during storage) but is a volatile fraction of petroleum made up of pentanes and hexanes. Petroleum ether may also be known as ligroin or benzine.

Anesthetic ether that has been stored for several years can form crystalline solids, called ether peroxides, on the inside lid of the container. Once peroxides have formed, this diethyl ether is dangerously explosive.

The following procedures should be closely followed in any use of anesthetic ethers:

Ordering Parameters

1. Order only as much diethyl ether as you will use during the school year because exposure to air causes the formation of peroxides that are explosive and sensitive to heat. Small, "single use" bottles (25 ml and 50 ml) are available. After use, allow the remainder to evaporate, if appropriate.
2. Order diethyl ether only. Other types of ethers are not to be used in schools. (Petroleum ether is not herewith restricted because it is not a true ether.)

Storage and Inventory

1. Date each container when received.
2. Use oldest cans first.
3. Use the entire can of ether as soon as possible after the seal is broken.
4. Never store ether in a glass container.
5. Never store diethyl ether for more than 12 months.
6. Store ether in a cool, dark location.
7. Never store ether in a refrigerator, unless the refrigerator is certified explosion proof.
8. Never open a container of ether if the age or condition is uncertain. Any shock or vigorous motion might cause an explosion. Do not open the cap or stopper because the motion might be sufficient to cause an explosion.

Use of Ether in the Classroom

1. Use only when no alternative solvent is available.
2. Never have an open flame or spark source in a room in which ether is being used.
3. Keep the work area well ventilated.
4. Use minimal quantities.
5. Remember that ether vapor is heavier than air. The hazardous area is made greater because vapors spread along the floor.

Ether Spills

Ventilate and evacuate the area.

Disposal of Ether

1. To dispose of any old, rusty, swollen, or suspect container of diethyl ether, immediately call the appropriate school district staff member or your local fire or county sheriff's department (noted on the inside front cover of this handbook).
2. To dispose of diethyl ether less than 12 months old, place the opened container under a fume hood or outdoors and allow to evaporate.

J Standards in the Use of Lead

The California Department of Health Services has recommended that lead and lead compounds *not* be used in the high school laboratory. Overexposure to lead can cause damage to the reproductive systems of both men and women. Effects of the damage include stillbirth, miscarriage, and learning disorders in children whose mothers were exposed to lead during pregnancy. Lead also damages the nervous system, kidneys, blood-forming system, and digestive system. (See also Table 3.)

If lead must be used in the laboratory, the Cal/OSHA lead standard must be followed (see *California Code of Regulations, Title 8,* Section 5216). Some of the main points of the lead standard are as follows:

1. When lead is used, the amount of lead in the air in the work area must be measured at least once.
2. If the levels of lead in the air exceed the action level (an average of 30 micrograms of lead per cubic meter of air throughout an eight-hour workday), the employer must:
    a. Measure the level of lead in the air every six months.
    b. Tell employees, in writing, the amount of lead to which they are exposed.
    c. Establish an exposure reduction program if employees are exposed to more than the action level for more than 30 days each year.
3. Employee exposure must not exceed the permissible exposure limit (PEL) on any day. If employee exposure to lead on a given day is over the PEL (an average of 50 micrograms of lead per cubic meter of air throughout an eight-hour workday), the employer must:
    a. Measure the level of lead in the air every three months.
    b. Tell employees, in writing, the results of air monitoring and what will be done to reduce exposures.
    c. Provide employees with proper respirators until the exposure has been lowered by other controls.
    d. Prohibit eating, drinking, smoking, or applying makeup in areas in which lead levels are above the PEL.
    e. Be sure that employees wash hands before eating, drinking, smoking, or applying makeup.
    f. Provide a changing room, lunchroom, and shower facility at no extra cost to employees.
4. If employees are exposed to lead at or above the action level, the employer must offer medical evaluations at no cost to the employees.

The Department of Health Services strongly recommends that instructors replace lead and lead compounds with less hazardous substances. If lead is going to be used, the Department of Health Services recommends the following procedures:

- Only instructors should be allowed to handle powdered lead and lead compounds.
- When handling solid lead compounds (other than lead weights) or solutions containing lead, students must wear laboratory coats, gloves, and goggles.
- The instructor must inform students of the need for strict personal hygiene and adherence to safety guidelines when using lead.
- The instructor is responsible for cleaning up any spills.

K Handling and Cleanup of Mercury

Teachers should use the smallest possible quantity of metallic mercury to perform the experiment and keep the mercury away from heat at all times. When mercury is handled, it should be done closely over a glass or plastic tray to facilitate any cleanup that may be necessary. (Drops of mercury that fall some distance to a counter or floor will spatter and spread in finely divided particles.) Take care that mercury is not put into a sink. All spills should be properly noted, in writing, and carefully cleaned up.

Mercury spills must be cleaned up as thoroughly as possible to reduce the long-term presence of mercury vapors in the classroom or preparation area. However, note the following precautions:

- *Do not sweep the spill with a broom.* (The broom becomes contaminated, and free mercury vapor is produced.)
- *Do not use a standard vacuum cleaner.* (The vacuum cleaner becomes contaminated, and free mercury vapor is produced.)

Suggestions for cleaning up mercury spills are as follows:

1. Assess the extent of the spillage. If the spill is minor (e.g., a broken mercury thermometer) and confined to a small area, clear the area and restrict access; provide maximum ventilation; and proceed with the cleanup. If the spill is more extensive, clear the room of students; ensure that

ventilation is sufficient before cleaning up. Placing plastic bags over your shoes may be advisable to avoid extending the mercury contamination beyond its original area.

2. Use index cards to push drops of mercury together into pools. Droplets may scatter a considerable distance and adhere to vertical surfaces as well.
3. Use a medicine dropper with a fine point to pick up the mercury and place it in a plastic bottle. Continue gathering and confining the mercury until all visible droplets have been found.
4. Use zinc metal powder or commercially available mercury "sponges" to continue to clean up tiny and hidden droplets. (*Caution:* Keep zinc metal powder dry because it is spontaneously combustible when wet and may even explode if confined. See *zinc* entry in Table 3.) Zinc metal reacts with mercury to form a safe amalgam, which is easier to collect and dispose of than the mercury itself.

Mercury indicators (detectors) and mercury cleanup kits, which would be effective for small or modest spills, are available at relatively low cost through chemical and safety supply companies. Special attention should be given to larger spills, possibly including the rental of a mercury vacuum cleaner.

6

SAFETY IN THE PHYSICS LABORATORY

A. General Safety Practices 77

B. Electrical Devices and Connectors 78

C. Model Rocket Launchings on School Sites 78

D. Use and Hazards of Lasers 79

Note: Procedures discussed in this handbook involve potential dangers to persons, animals, and other living things and, therefore, should be performed only by persons who are technically trained and qualified.

6. SAFETY IN THE PHYSICS LABORATORY

PHYSICS TEACHERS SHOULD BE FAMILIAR WITH the following safety practices and all other sections of the handbook pertinent to their instructional program. Special attention should be directed to Chapter 3, "General Laboratory Safety Precautions"; Appendix H, "Safety Checklist for Science Instruction, Preparation, and Storage Areas"; and Appendix P, "Sample Physical Science Laboratory Regulations."

A General Safety Practices

1. In wiring an electric circuit, make the live plug-in, or turn-on switch connection, the last act in assembling and the first act in disassembling the circuit. This practice is applicable to all portable electrical apparatus. All alternating current (AC) circuits above 12 volts should be shielded to avoid direct contact.
2. When using an electric current, avoid bringing both hands in contact with live sections of the circuit. If possible, use only one hand at a time in all manipulations involving an electric circuit.
3. Electrical cords and extension cords used in the classroom should be inspected regularly for defects in insulation or connections. All extension cords should be the heavy-duty, three-wire, grounded type. Extension cords should never be used to connect electrical equipment permanently to the circuit.
4. If electric current is constantly used near any metal object, the object should be permanently protected with an insulating cover to avoid possible contact. Take care that live wires do not contact grounded metallic objects.
5. Multiple plugs shall not be used in electrical wall outlets. Semipermanent electrical connections shall not be made to wall outlets. Under no circumstances shall a motor requiring a starting current of more than 20 amps be connected to a wall outlet.
6. During the charging of a student-made wet storage cell, keep students away from the fine spray that develops. It is harmful when inhaled or allowed to get on the skin or in the eyes.
7. Teachers and students should be cautious when handling a lead/acid or similar storage battery. It is a source of danger in spite of its low voltage because of the acid it contains and because of the high current that may be drawn from it on a short circuit. Storage batteries should be charged only in a well-ventilated space. Battery sparks have enough energy to ignite flammable vapors. Hydrogen gas, which is potentially explosive, is produced during charging.
8. Induction coils of any type should be clearly marked for low-voltage and high-voltage connections to avoid the possibility of shocks.
9. Instructors and students should be shielded at all times from ultraviolet apparatus and during the use or production of X rays, microwaves, and lasers.
10. When handling electronic equipment, teachers and students should observe the following precautions:
    - Make certain that the current is off before putting hands into a radio or any electronic equipment.
    - Be sure that there is a bleeder (high resistance) across the output of a power supply; otherwise, a severe shock from a charged condenser may result.
    - Exercise extreme caution in demonstrating, adjusting, or using image tubes of television receivers or cathode-ray oscilloscopes when the tubes are removed from their protective housing. Such tubes should be removed only when necessary to the experiment.
11. When evacuating a bulb during the density of air experiments, wrap the bulb in a towel to avoid flying glass should the bulb be crushed. Use round-bottom flasks for the experiment; they are stronger than flat-bottom flasks.
12. When using a pressure cooker to demonstrate the variation of boiling points under pressure, be sure to examine the safety valve on the cooker before use to make sure it is in working order. Do not allow the pressure to exceed 20 pounds per square inch (137.8 kPa).
13. Observe caution in the use of all rotating apparatus, such as the whirling table, Savart's Wheel,

siren disk, and centrifugal hoops. Make certain the safety nut is securely fastened at all times. The apparatus should revolve at moderate speeds only.

14. Care should be taken to prevent injuries from the sharp edges on mirrors, prisms, and glass plates. Inspect the items before handing them to students and remove sharp edges by grinding them with emery cloth or Carborundum stone or painting them with quick-drying enamel. Instruct students to report at once any sharp-edged apparatus.
15. The practice of removing thermometers, glass tubing, and so on from rubber stoppers as soon as possible after use will reduce the likelihood of the rubber adhering to the glass. The best ways in which to remove a thermometer, rod, or glass tubing that is stuck in a rubber stopper are as follows:
    - Use a wet cork-borer, just large enough to slip over the tubing, and slowly work the cork-borer through the stopper, thus boring the stuck tube out of the stopper.
    - Use a single-edge razor blade or razor knife to slit open the rubber stopper surrounding an immobilized thermometer.

B Electrical Devices and Connectors

The use of electricity can present a serious hazard in the classroom or laboratory. Electrical devices used in the laboratory or classroom should be only those listed by Underwriters Laboratory (UL), or equivalent, for 110-volt outlet application or those listed for use with 6-volt or 12-volt direct current furnished by batteries.

Electrical devices should never be used or placed near any source of water or in an area subject to wetting from any source. Exercise special care in the placement and use of aquariums, particularly when using a 110-volt light source.

Instructors should caution students that any projects they submit must meet the specifications noted above or will not be accepted.

Some guidelines for safety in the use of electrical equipment are as follows:

1. Use only those 110-volt devices included in the list by Underwriters Laboratory or equivalent.
2. Use 6-volt or 12-volt direct current for all possible applications.
3. Operate electrical devices with dry hands and in a dry location.
4. Be sure the floor is dry. Never stand on metal or any other conducting surface when using electrical devices. Ground fault circuit interrupters (GFCIs) should be on electrical outlets near sinks.
5. Never allow yourself to become part of an electrical circuit, intentionally or unintentionally.
6. Ensure that power equipment or devices are double-insulated. Or have them safely grounded (three-prong plug) by a competent electrician.
7. Use extreme care with aquariums when they have an electrically operated pump or electrical light source.
8. Use extension cords with extreme caution and never allow them to lie across areas of foot traffic.
9. Be sure multiple-outlet bars have fuse protection or some other circuit breaker.

In compliance with *California Code of Regulations, Title 8*, Electrical Safety Orders, Section 2395.44, exposed noncurrent-carrying metal parts of cord- and plug-connected equipment that are likely to become energized shall be grounded. This equipment includes motor-driven equipment and hand tools, time clocks, fans, lamps, vacuum cleaners, and similar equipment as well as heating devices that have exposed heating elements. Heating appliances that have a metal frame must be grounded. Heating appliances with Cal-rod types of fully enclosed elements do not require grounding.

All nonportable electrical devices must be plugged directly into permanent electrical outlets, not into extension cords.

C Model Rocket Launchings on School Sites

California state fire laws permit the launching of model rockets on school sites provided the following safety precautions are followed (see Appendix Q for further guidelines):

1. The teacher should use prudent judgment and limit the number of launchings when students are present in the audience.
2. Only authorized classes or clubs should engage in this kind of activity on school sites.
3. Application for a special permit may be required by local fire protection agencies. If a permit is

issued in the name of the school administrator, it is incumbent also on the instructor to comply with all safety standards. The school administrator should determine compliance.

4. The length of the rocket must not measure less than 10 inches (25 cm) or more than 15 inches (38 cm).
5. Only commercially produced class A or smaller engines are recommended.
6. The minimum size of the launch site for class A or smaller engines should extend to a radius of 100 feet (30 m) from the firing position.
7. No fire hazard may be posed by the launch. That means no dry vegetation or forest areas may be within the launch radius.
8. No buildings, other structures, roads, or high-voltage electrical lines may be within the launch radius.
9. The firing area should be at the center of the launch radius. In no case should the firing area be closer than 25 feet (8 m) from the boundary of the launch site.
10. Teachers should caution their students about the dangers of experimenting with rockets and missiles, especially the dangers in the preparation and use of noncommercial rockets and propellants. Teachers must refrain from the following:
    - Providing chemicals for rockets or missiles or helping students to obtain them
    - Using, or permitting to be used, liquid or solid fuels in the classroom (Such use essentially constitutes a controlled explosion.)
    - Permitting the construction of rockets, missiles, or component parts in the classroom or shop
    - Allowing students too close to the firing area
    - Launching anything other than commercially produced rocket engines of known size and predictable range

D Use and Hazards of Lasers

Lasers are valuable sources of light to use in exciting demonstrations and laboratory experiments in school. Most school lasers are relatively low powered, with a light emission of less than a thousandth of a watt. These lasers should not be confused with the powerful lasers intended for burning, cutting, and drilling. However, science teachers should still be aware of the inherent dangers to personnel in the operation of lasers. Before using lasers in demonstrations or in research, orient all involved personnel to the potential hazards. In general, school demonstration lasers emit visible light; therefore, students and teachers face hazards typical of visible and near-infrared light.

Eye Hazards

Possibly the greatest danger in the use of lasers is the accidental penetration of the laser beam into the eye. Relatively low-power beams may burn the retinal area, producing a blind spot. If the retinal area irradiated is the macula, its fovea (area of extremely fine vision), or the optic nerve, severe permanent visual damage may result.

Skin Hazards

The effects on the skin are basically those of burns. Lighter skin with little melanin pigment is affected to a lesser degree, but skin with high melanin content (overall or in spots, such as moles) may be burned severely. Conversely, lighter skin does not protect deeper-lying tissue from visible and near-infrared irradiation damage as well as darker skin does.

Exposure to ultraviolet irradiation may result in "sunburn" and possibly in skin cancer in susceptible individuals.

CDRH Regulations

The Center for Devices and Radiological Health (CDRH) of the United States Food and Drug Administration requires the manufacturers of lasers to classify their lasers according to a federally mandated system and specifies appropriate safety features for each level. Lasers are classified on the basis of emitted beam power. These regulations are detailed in the Federal Laser Product Performance Standard (*Code of Federal Regulations, Title 21*, Part 1040), and all commercially available lasers built after the implementation of the regulations (August, 1976) must comply with the standard as it existed on the date of manufacture.

Lasers that fall into class I require no warning labels because the CDRH believes that no injury can result, even from continuous long-term direct exposure to the beams.

A class II laser should be identified by a yellow *Caution* label that contains the warning *Do not stare into beam.* A class IIIa laser should be identified by a red *Danger* label that contains the warning *Avoid direct eye exposure.*

In addition to the CDRH label, each laser that is class II or higher should have the following label placed near the beam exit: *Avoid exposure. Laser light is emitted from this aperture.* The CDRH also requires the manufacturers to provide users with the following information: *Caution—Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous light exposure.*

Laser Precautions

Most lasers in use in secondary schools are continuous-wave (cw) helium-neon lasers that emit a beam of red light. Invisible, exotic, or other harmful radiation is not emitted. These lasers are typically class II or class IIIa lasers. It is important for the teacher to be aware of the classification of the laser being used.

Class II (cw) lasers have a maximum power of 1 mW, a power judged to be eye safe because the natural blink reflex prevents excessive power absorption in the eye. However, deliberate, direct staring into the beam for periods longer than one-quarter second may result in injury. Safety features include warning labels, a pilot lamp that glows when the electrical power is on, and a mechanical beam stop that may be used to block the beam when the power is on.

Class IIIa (cw) lasers that emit visible light have a maximum power of 5 mW, a power that may be too high for the blink reflex to provide protection against injury. Class IIIa lasers that emit outside the visible spectrum may be limited to lower power output. Safety features of the class IIIa laser include the safety requirements for the class II laser, a key switch, and a connector for optional remote control operation.

For lasers purchased before August, 1976, the claimed optical power is not a reliable index of the output. Tests have shown that such lasers rated at 1 mW radiated in the range of 0.19 to 3 mW.

Lasers with cw outputs greater than 5 mW, pulsed lasers, and lasers emitting radiation at wavelengths outside the visible and near-infrared light present additional hazards. Schools using such lasers should have a copy of the *American National Standard for the Safe Use of Lasers*, ANSI Z136.1-1992, published by Laser Institute of America, 12424 Research Parkway, Suite 130, Orlando, Florida 32826.

Even though the power of a laser may be low, the beam should be treated with caution and common sense. Many laser hazards may be avoided by implementing the following measures:

1. *Avoid direct viewing of the beam.* Instruct students not to look directly into the laser beam or its bright reflections, just as they should not look directly at the sun or at arc lamps. As a general practice do not place any portion of the body in the path of the beam. These practices become increasingly important as the power of the laser device's output increases. Good work practices, developed early, will assist the individual later in working safely with more hazardous lasers.
2. *Know the location of the beam's path and keep it clear of extraneous objects.* All optical components should be fixed in position in relation to the laser before the beam is propagated to ensure that the beam's path does not change in an uncontrolled manner. Objects with mirrorlike finishes (e.g., plumbing fixtures, personal jewelry, and tools) reflect laser beams in unexpected directions. If possible, such surfaces should be removed from the vicinity of the beam's path. Demonstration equipment, such as support rods, bench surfaces, and adjustment tools, should be painted or treated to produce a dull, nonreflective surface.
3. *Block the beam when it is not needed.* The mechanical beam stop should be opened to allow beam emission only when necessary for measurements or observations. It should always be closed when an optical element is being inserted into the beam's path or is being relocated.
4. *Terminate laser beams.* Block off the beam at a point beyond the farthest point of interest. All laser beams should be terminated in a nonreflective, light-absorbing material. For higher power lasers (>0.5 W) the material should also be nonflammable.
5. *Prepare and test demonstrations when no one else is present.* Demonstrations should be prepared and tested by the instructor when no one else is present. All unwanted reflections should always be tracked down and eliminated or blocked.
6. *Deflect the beam in a vertical plane in complex demonstrations.* In normal experimental situations the laser beam's path should be kept in a horizontal plane at a level below or above the eye level of the instructor and observers. Complex demonstrations involving reflection or refraction should be

conducted with the beam's deflection angles contained in a vertical plane to reduce the possibility of directing a stray reflection into the audience. The laser display system should be contained in a box that is open on the side(s) but closed on the ends, top, and bottom. If the beam must travel a long distance, keep it close to the ground or overhead so that it does not cross walkways at eye level.

7. *Affix expanding lenses rigidly to the laser.* When the laser is used to illuminate large surfaces, such as in the viewing of holograms, beam-expanding (diverging) lenses should be fixed rigidly to the laser.
8. *Equip the laser with a key switch.* The laser should be equipped with a key switch in the primary power circuit, rather than with the more commonly used kind of toggle switch. Key switches are available from electronic supply stores for a relatively small charge. An additional switch that requires constant pressure is also desirable.

   Although installing a key switch is desirable, a retrofit may void the manufacturer's warranty. It is advisable to have an electrical technician perform this operation.
9. *Do not leave an operable laser accessible and unattended.* The key should be removed and placed in a secure location to prevent unauthorized use of the laser and possible injurious exposures. For the same reason, when experiments or demonstrations take place in areas that might permit access to the beam by individuals not under the control of the teacher, a responsible person should be assigned to stop the beam's emission if such access to the beam appears imminent.
10. *Reduce the optical power of the laser.* The optical power used should be reduced to the minimum necessary to accomplish the objective of the experiment or demonstration. Neutral density filters or colored plastic can be used effectively to reduce radiated optical power.
11. *Keep the area well lighted at all times.* Good lighting tends to keep the pupil of the eye relatively contracted and reduces the amount of light that might impinge on the retina accidentally when the laser system is in use.
12. *Provide and use adequate eye-protective devices.* Protecting the eyes with shatter-resistant goggles is essential when using some types of laser systems, but no one kind of goggle offers protection from all wavelengths. Make sure that proper goggles are available and used (see Chapter 7, section C, "Eye Safety").
13. *Shield the pump source.* Flashlamps or arc lamps are used to transmit energy into the laser material in solid-state lasers. The high-intensity light generated by those lamps should not be viewed directly. The broadband white light of the lamps is not completely blocked by laser-protection eyewear. Enclosure of the lamp in an opaque housing is essential.

Electrical Safety with Lasers

Helium-neon lasers employ high voltages similar to those employed inside a small television receiver. Capacitors within the power supply retain the potentially harmful voltage for some time after the input of power has ceased. Flashlamp power supplies typically involve higher stored energies and higher voltages than those involved in the helium-neon lasers. Maintenance of these systems, such as changing the lamps, requires direct personal contact with the high-voltage conductors.

School personnel must avoid the possibility of electrical shocks from both high-voltage and low-voltage equipment, including storage capacitors and power supplies, by disconnecting the equipment from the primary power source and using proper techniques for the removal of stored energy before performing maintenance or service activities.

Each laser should be equipped with a UL-listed line cord and a three-prong grounded plug. *Always plug the laser into a grounded outlet.*

Conductive optical tables must be effectively grounded.

7

ADDITIONAL SAFETY PRACTICES

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Note: **Procedures discussed in this handbook involve potential dangers to persons, animals, and other living things and, therefore, should be performed only by persons who are technically trained and qualified.**

7. ADDITIONAL SAFETY PRACTICES

THIS CHAPTER DEALS WITH GENERAL SAFETY practices that apply to various areas of science instruction.

A Fire Prevention and Control

If a serious classroom fire occurs, the teacher should conduct a fast, orderly evacuation of the room. The fire should be reported immediately, and control measures may be taken if the fire is localized and does not present imminent danger. Both teacher and students should know the location of the nearest fire alarm, fire blanket, and fire extinguisher. The teacher should know how to use those fire-control devices.

When an open flame is used in the classroom, caution students to stay well away from the flame. Never reach across the flame area. If hair or clothing becomes ignited, douse with water. A fire blanket can be used to smother the flaming area if water is not immediately available in sufficient quantity. (See the end of this section for use of a fire blanket.) Do not use a fire extinguisher on a person because it can cause serious chemical burns or frostbite (in the case of a CO_2 extinguisher).

In an electrical fire, pull the plug if that can be done without sustaining a burn (the cord might be hot) or becoming a part of the circuit. Do not use water because water is a conductor of electrical current.

Many substances and types of chemical reactions involved in science programs present potential fire hazards. The teacher must anticipate the possible causes of fire and be ready to act swiftly if a fire occurs despite the preventive measures taken.

The most common causes of fire in the science laboratory are (1) failure to understand the nature of the supplies or equipment being used; and (2) careless handling of supplies or equipment.

The following extinguishing procedures are recommended for different kinds of fire, as indicated:

1. Class A fires are fires in wood, paper, fabrics, and other common combustibles. Cool the fire with water or use a general-purpose dry-chemical extinguisher (for use with all class A, class B, and class C fires).
2. Class B fires involve gasoline, oil, paint, alcohol, or other volatile flammable liquids. Smother the fire by using carbon dioxide (CO_2), dry-chemical, or foam extinguishers. Aim at the base of the flame with the CO_2 extinguisher and do not hold the nozzle (horn) because of the danger of frostbite. Foam should be floated over the fire. Expel the entire contents of the extinguisher.
3. Class C fires are fires in live electrical devices. Use a nonconductive substance to prevent yourself from becoming a part of the electrical circuit. Use a CO_2 or dry-chemical extinguisher. Shut off the electrical power if it is possible to do so without sustaining a burn.
4. Class D fires occur with combustibles, such as magnesium, titanium, potassium, sodium, zirconium, or other reactive metals. You need a special extinguishing powder for those fires. Do not use regular dry-chemical extinguishers. Dry sand is effective on small class D fires. Call the fire department and inform them that it is a class D fire. Never use water or sand that is damp.

Multipurpose (2A-10BC) fire extinguishers are mandatory (*California Code of Regulations, Title 19*, Section 568 et seq.). The State Fire Marshal requires that one extinguisher be provided for every 6,000 square feet (540 sq m) of laboratory space and that one be located not more than 75 feet (22.5 m) from any point in the laboratory on the same story or floor.

The following items of equipment are recommended for use in classroom fires:

- General-purpose (ABC) dry-chemical fire extinguisher. *Not for use with class D fires.*
- Carbon dioxide (CO_2) fire extinguisher. *Not for use with class A or class D fires.*
- Fire blanket for fires involving clothing on persons. The victim should stop, drop, and roll immediately on the floor to minimize inhalation of smoke or hot gases. Someone should assist the victim in rolling up in the fire blanket, starting with the upper portion of the body to force flames away from the head but making sure that the head is free.

B Use of Animals in the Classroom

A science teacher or other adult supervisor should assume primary responsibility for the environmental conditions under which any study involving live animals is conducted. If the school faculty does not include persons with training in the proper care of laboratory animals, the services of such a person on a consulting basis should be sought. A local veterinarian may offer this kind of help.

All animals used in the classroom must be lawfully acquired in accordance with state and local laws. All mammals used in a classroom should be inoculated for rabies, unless they were purchased from a reliable scientific company. All live-animal studies must comply with *Education Code* Section 51540 (see page 85 and Appendix B).

The following animals should never be brought into the classroom: wild birds and mammals, snapping turtles, poisonous snakes, and insects that may be carriers of disease. Students should not bring their pets to the classroom unless the activity is carefully planned by the teacher and approved by the administrator. Dead animals found by the side of the road should never be brought into the classroom because they may carry hazardous bacteria or parasites.

Before a suitable small animal is allowed in the classroom for observation, plans should be made for the animal's proper habitat and food. The living quarters of animals in the classroom must be kept clean, free from contamination, and secure enough to confine the animals. Plans must be made for the care of classroom animals during weekends and vacation periods.

Animals should be handled properly, according to the particular animal, and only when necessary. Special handling is required if the animal is excited or when it is feeding, pregnant, or with its young. (See also Chapter 4, section M, "Handling of Laboratory Animals.")

Students should wash their hands after handling turtles, snakes, fish, frogs, toads, and so forth. Make sure that the water from the habitat is disposed of carefully. Turtles should be purchased only from sources that certify that the turtles are free of salmonella.

Teachers should caution students never to tease the animals or to insert their fingers or objects through wire mesh cages. Any student who is bitten or scratched by an animal should be sent immediately to the school nurse for appropriate treatment.

After a period of animal observation is completed, animals should be returned to their natural environment. (See *Caution* in the following section.)

Humane Care and Treatment of Animals

Keeping animals in the classroom can be conducive to the development of many learning situations. The humane care and handling of animals is paramount during such lessons. (See also Chapter 4, section M, "Handling of Laboratory Animals.") A respect for living things should be first in the minds of both teacher and student. Respect for life shall be accorded to all animals that are kept for educational purposes.

In biological procedures involving living organisms, teachers are encouraged to select such species as plants, bacteria, fungi, protozoa, worms, snails, arthropods, or insects, whenever possible. These species are especially suitable for student work because of their wide variety and ready availability in large numbers and because of the simplicity of their maintenance and of the return of native species to their natural environment, or their subsequent disposal, as appropriate.

Caution: Release of nonnative and exotic organisms may be detrimental to the local environment as well as illegal. Observations of animals in their natural habitat, including the community surrounding the school, should be encouraged. In mammalian studies nonhazardous human experiments are often educationally preferable to those using such species as rats, guinea pigs, or mice.

No procedure shall be performed on a vertebrate animal that might cause it pain, suffering, or discomfort or otherwise interfere with its normal health. Therefore, no surgery shall be performed on any living vertebrate animal (mammal, bird, fish, reptile, or amphibian). No lesson or experiment shall subject a vertebrate animal to any of the following:

- Microorganisms that can cause disease in humans or animals
- Ionizing radiation
- Cancer-producing agents
- Chemicals at toxic levels
- Drugs that produce pain or deformity
- Extremes of temperatures
- Stressful electric or other shock

- Excessive noise
- Noxious fumes
- Exhausting exercise
- Overcrowding
- Other distressing stimuli

Animal observations must be directly supervised by a competent science teacher, who shall approve the plan before the student starts work. Students must have the necessary comprehension and qualifications for the work contemplated. The supervisor shall oversee all experimental procedures, shall be responsible for their nonhazardous nature, and shall personally and continually inspect experimental animals during the course of the study to ensure that their health and comfort are fully sustained.

Vertebrate animal studies shall be conducted only in locations in which proper supervision is available, either a school or an institution of research or higher education. No vertebrate animal studies shall be conducted at a home (other than observations of normal behavior of pet animals, such as dogs or cats).

In vertebrate animal studies, animals shall be provided palatable food in sufficient quantity to maintain normal growth. Diets deficient in essential foods are prohibited. Food shall not be withheld for periods longer than 12 hours. Clean drinking water shall be available at all times (and shall not be replaced by alcohol or drugs).

Chicken eggs subjected to experimental manipulations that may produce abnormalities shall not be allowed to hatch. Such embryos shall be killed humanely no later than the 18th day of incubation. If normal egg embryos are to be hatched, satisfactory arrangements must be made for the appropriate care or humane relocation of chicks.

Projects involving vertebrate animals will normally be restricted to measuring and studying normal physiological functions (such as normal growth, activity cycles, metabolism, blood circulation, learning processes, normal behavior, reproduction, and communication) or isolated tissue techniques. None of these studies requires infliction of pain.

Regulations

State and local laws regulate the care and use of animals in both elementary and secondary science instruction. The treatment of animals in California public school instruction is regulated by *Education Code* Section 51540 as follows:

> **51540.** In the public elementary and high schools or in public elementary and high school school-sponsored activities and classes held elsewhere than on school premises, live vertebrate animals shall not, as part of a scientific experiment or any purpose whatever:
>
> (a) Be experimentally medicated or drugged in a manner to cause painful reactions or induce painful or lethal pathological conditions.
>
> (b) Be injured through any other treatments, including, but not limited to, anesthetization or electric shock.
>
> Live animals on the premises of a public elementary or high school shall be housed and cared for in a humane and safe manner.
>
> The provisions of this section are not intended to prohibit or constrain vocational instruction in the normal practices of animal husbandry.

Regulations about the use of animals in the classroom for educational purposes are also included in the *Health and Safety Code* of the state of California. These regulations state that animals used for experimental, educational purposes must be humanely treated, supplied with adequate food and water, and kept in satisfactory shelter and sanitary conditions. (See Appendix B for the applicable section of the *Health and Safety Code*.)

C Eye Safety

The sections of the *Education Code* (32030–32033) that regulate the duties and responsibilities of schools and school districts to protect the eyes of students, staff, and visitors during hazardous activities conducted in the classroom are cited in Appendix B. Those legal requirements are summarized in this section, followed by information on eye-protective devices and other eye-safety practices.

Legal Requirements

School district governing boards have the duty to equip schools with eye-protective devices for the use of all students, teachers, and visitors participating in hazardous activities, such as those outlined below. Principals or teachers supervising any of those activities must require that the eye-protective devices be worn by participating students, teachers, and visitors.

Handbooks, guides, and other instructional materials designed for use by persons involved in direct supervision of hazardous situations must carry additional, detailed guidelines covering particular subject areas and concerns.

Circumstances requiring eye-protective devices. Courses in which the eye-protective devices shall be worn include, but are not limited to, vocational or industrial arts shops or laboratories and chemistry, physics, or combined chemistry-physics laboratories at any time the individual is engaged in an activity or is observing the use of hazardous substances likely to cause injury to the eyes. Such activity includes, but is not limited to, the following:

- Working with hot metal
- Working with hot liquids or solids or with chemicals that are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, or radioactive or that generate pressure through heat, decomposition, or other means
- Working with materials or equipment under stress, pressure, or force that might cause fragmentation, including the use of hand or power tools with such hard materials as stone or metal

Standards for devices. The eye-protective devices used shall be industrial-quality devices that meet the standards of the American National Standards Institute (ANSI).

Sale of devices. If students and teachers wish to purchase their own eye-protective devices, the devices may be sold at a price that shall not exceed the cost of the devices to the school district.

Eye-Protective Devices

Eye-protective devices vary in form and effectiveness. Three basic types of eye and face protection are as follows:

- Goggles—primarily intended for eye protection against impact and splash. Goggles also serve to reduce the dust and fumes reaching the eye.
- Face shield—for partial personal face protection against splash or impact. Face shields should ordinarily be used in conjunction with goggles.
- Safety shield—for group protection from splash and impact. The safety shield should be used with goggles and, if appropriate, with a face shield.

Specifications for eye-protective devices include the following: (1) lenses must have a minimum thickness of 3 mm and be impact-resistant; (2) frames must be a lens-retaining type made of nonflammable material; and (3) goggles must be splash-proof. See Table 4 for further information about recommended supplies of eye-safety devices.

TABLE 4

Recommended Supplies of Safety Devices for Eyes

Device	Recommended Allowance
1. *Goggles*—plastic, splash-proof, vented (standard Z87.1)	One class set of 35 for each school science laboratory (This number allows for visitors, breakage, and loss.)
2. *Goggles*—plastic, splash-proof, nonvented	Five for each science laboratory
3. *Face shield*—quickly adjustable	One for each teaching station, preparation room, and project room
4. *Cabinet*—germicidal, ultraviolet, capacity 35 goggles	One for each class set of goggles
5. *Safety shield*—flat	One for two classrooms
6. *Safety shield*—curved	One for two classrooms

Note: These eye-protective devices should not be considered 100 percent effective against all potential eye hazards. Appropriate combinations of devices may be used for optimum protection.

To establish an effective eye-safety program, the teacher must comply with the following practices:

1. Orient the students to the need for and use of eye-protective devices.
2. Warn students that contact lenses may not be worn in an atmosphere that may contain hazardous gases, vapors, or liquids or when there is any danger of chemicals entering the eye (see accompanying box, "Use of Contact Lenses").
3. Consider eye safety when planning each science activity. Refer to Chapter 2, section D, "Eye Injuries," and the following subsection in this chapter, "Potential Eye Hazards." Ensure that all persons performing science laboratory activities involving hazards to the eyes wear approved eye-protective devices. All persons in dangerous proximity to such activities must be similarly equipped.

Use of Contact Lenses

The use of contact lenses in science laboratory instruction is strongly discouraged because the capillary action of solutions causes rapid spreading of the solution under contact lenses and possibly delays the removal of the lenses. Quick removal of contact lenses is very difficult under adverse conditions. When laboratory activities are anticipated, prescription glasses should be worn unless a student cannot see without contact lenses. Contact lenses are also not to be worn when a dust or vapor hazard exists unless vapor-resistant goggles are available. It is essential to provide approved nonvented protective goggles promptly to students, teachers, and visitors wearing contact lenses and to ensure that the goggles are worn regularly. If adequate eye protection cannot be provided, the student should be excused from the activity and assigned to another supervised room or area.

4. Establish routine procedures for the distribution of the individual eye-protective devices, when needed, and for their subsequent return to the storage case.
5. Establish a definite, readily accessible location in the designated areas for each type of eye-protective device. An accessible germicidal ultraviolet storage cabinet is an appropriate location for goggles because it serves the dual purpose of storing and sterilizing the goggles.
6. Maintain reasonable standards of cleanliness because eye-protective devices will usually be shared by several persons. Use of germicidal cabinets or dips is highly recommended along with frequent, thorough washing. Although these procedures do not sterilize, they do sanitize, which is safer than no cleaning at all. Students with unhealthy, possibly contagious skin or eye conditions should be encouraged to purchase personal safety goggles; or specific goggles should be reserved for the students' exclusive use.
7. Consider the special requirements of the storeroom, preparation room, and project room activities. Because of the greater probability and severity of many eye hazards in storerooms, preparation rooms, and project rooms, all persons performing or observing hazardous activities in those areas must be equipped with the splash-proof plastic goggles and other approved eye-safety devices specified for those areas.

Potential Eye Hazards

Eye-protective devices must be provided for participants and observers in activities involving, but not limited to, the following conditions:

1. Impact hazards
   - Conducting pneumatic pressure or evacuation operations, including use of the pressure cooker
   - Operating power tools
   - Operating centrifugal (centripetal) devices
   - Conducting projectile and collision demonstrations
   - Handling elastic materials under stress; for example, springs, wires, rubber, glass
   - Working with or igniting explosive or implosive devices or substances
   - Working with hot molten metals
   - Hammering, chipping, or grinding rocks, minerals, and metals
   - Cutting or breaking glass
2. Hazardous substances
   - Pouring, pumping, or dispensing corrosive substances
   - Generating toxic or potentially explosive gases
   - Mixing chemicals that react violently
   - Preserving and staining biological specimens

  - Cleaning and sterilizing with corrosive substances, including ammonia, detergents, or solvents

3. Hazardous radiation
  - Direct viewing of the sun (*Note:* No approved eye protection is provided. *Do not allow this activity.)*
  - Use of infrared and ultraviolet light sources (*Note:* No approved eye protection is provided. These sources must be shielded from direct view.)
  - Use of lasers (*Note:* No approved eye protection is provided. These sources must be shielded from direct view. See Chapter 6, section D, "Use and Hazards of Lasers.")

An effective eye-protection program must include adequate instruction and demonstration on the hazards of laboratory work and the methods with which to avert accidental injury. This instruction must be repetitious and should become routine procedure. The eye-protective devices must be readily available whenever needed, and high standards of cleanliness must be maintained to prevent any spread of infection from contagious eye or skin conditions. Students must be cautioned never to rub their eyes or touch their faces during any activity using reagents or substances that could be transferred through their hands. Students should scrub their hands thoroughly after any such laboratory exercise.

D Eyewash Station

An eyewash station should be provided in any classroom or stockroom in which a chemical splash into eyes is a possibility (*California Code of Regulations, Title 8,* General Industry Safety Orders, Section 5162; see Appendix B). Several types of stations are possible, including:

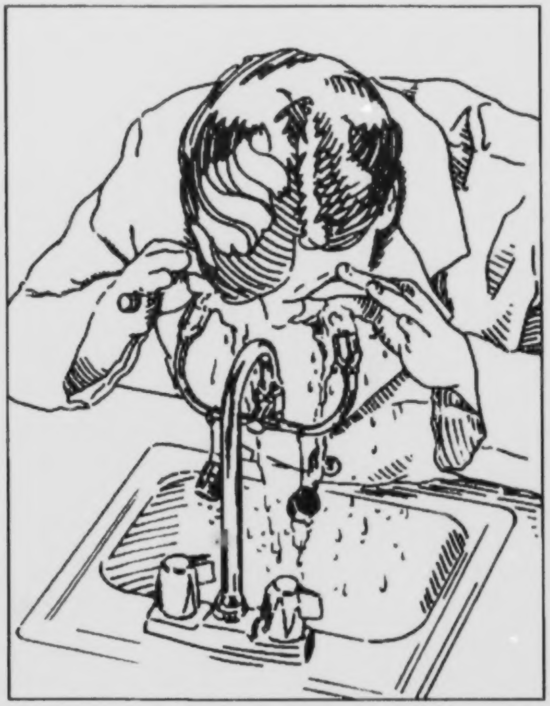
- A completely plumbed-in or self-contained eyewash or eyewash/facewash station
- A faucet-mount eyewash or eyewash/facewash unit that attaches directly to an existing faucet and also allows for normal faucet usage

A face-and-shower-head drench hose, operated by a squeeze handle, may support plumbed or self-contained units but may not be used in lieu of them (unless specially designed with separate flushing sprays for each eye). The shower head should be on a hose that pulls out of the counter and is installed next to an existing sink, over which the face can be held as the eyes are washed.

E Safety on Field Trips

Field trips afford unique learning opportunities and often include hazards not encountered in the classroom/laboratory. They should be carefully planned and should include provisions for transportation, protection against on-site hazards, and supervision (see NSTA position statement in Appendix A). The teacher should visit the site beforehand to assess the hazards so that they can be considered in the pretrip orientation and in communications with parents or guardians.

Permission slips should be completed and signed by parents or guardians (see sample form in Appendix R). The document should include details of the trip and provide an opportunity for parents or guardians to indicate any reason (medical, psychological, or religious) for their children to be exempted from the activity or be given special consideration during the activity because of conditions resulting from medication, allergies, and so forth.



The nature of the field trip activity and the environment will dictate supervision needs. Ordinarily, there should be a minimum of one adult per ten students unless district policy indicates otherwise.

A first-aid kit (see Appendix D) is required whenever a group takes a trip away from school. If the field trip is conducted in an area known to be infested by poisonous snakes, be aware of the precautions about poisonous snakebites described in Chapter 2 of this handbook. After a first-aid kit is used, the contents should be replenished if necessary.

Students should be informed about the most appropriate kinds of clothing to wear on particular field trips. Students should be instructed to wash their hands and faces with a strong soap immediately after any exposure to hazards, such as poisonous plants, in the environment (see the following section of this chapter).

Special precautions should be taken when trips are conducted on or near deep water. Special precautions should also be taken when trips are conducted in areas in which participants are likely to come into contact with animals or organisms that spread diseases, such as the Hanta virus, Lyme disease (spirochete), and valley fever (coccidioidomycosis).

The Hanta virus is spread by rodents in the natural regions and is found especially around and in primitive, abandoned, or seasonally used buildings in California and other states. The virus is often inhaled with the dust in which saliva, urine, or feces from rodents have intermingled. Special decontamination measures should be taken when participants come into contact with owl pellets because of the possible consumption by the owls of infected rodents. Consult your county environmental health department for decontamination procedures.

Lyme disease is more prevalent along the north coastal region of California. The spirochete that causes the infection is injected during the bite of certain ticks and may also be transmitted to other mammals (including pets) and birds. Arthritis, heart problems, and nervous disorders may result from the disease, which is characterized in its early stages as a skin rash that is hard at its center. Students should take special precautions, such as wearing protective clothing and checking the clothes and body frequently for ticks. Students should shower as soon as they return home and carefully check for ticks again at that time.

Valley fever, or coccidioidomycosis, is discussed in detail in Chapter 4, section E, and in Appendix S.

F Poisonous Plants

Biology and general science teachers should be prepared to warn students about the dangers of poisonous plants that grow in California. Special attention should be given to poisonous plants or plants with poisonous parts that are (1) included in the school landscaping; (2) brought to school for plant studies; or (3) likely to grow in areas in which field trips are planned. Teachers are encouraged to become acquainted with and teach about poisonous plants growing around homes, parks, streets, and recreational areas in the school district.

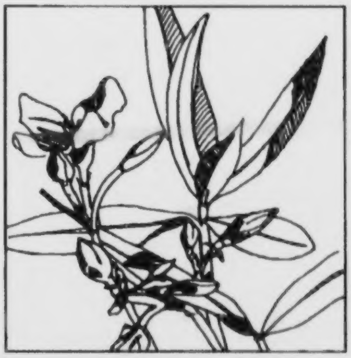
Because not *all* plants have been thoroughly researched for their toxicity, a commonsense rule would be *never* to do any of the following:

- Never place any plant part in the mouth.
- Never rub any sap or fruit juice into the skin or an open wound.
- Never inhale or expose the skin or eyes to the smoke of any burning plant or plant parts.
- Never pick strange wildflowers or cultivated plants that are unknown.
- Never eat food after handling plants without first scrubbing the hands.

The reason for these *never* precautions is that any part of a plant can be relatively toxic, even fatal, depending on the weight of the person and the amount of the plant ingested. See Table 5 for further information about some poisonous plants.

Students frequently place seeds in their mouths unconsciously. The danger in this habit lies in the possibility not only of swallowing a poisonous species but also of falling prey to the practice of commercial distributors who coat their garden and crop seeds with hormones, fungicides, and insecticides. Some of those items cause allergic skin responses. The remainder are usually deadly when inhaled to any degree or accidentally ingested. Teachers purchasing seeds for experiments from dealers should investigate the presence of any such coating or sprays and ask the dealer whether the seeds have been chemically coated.

TABLE 5
Effects of Some Poisonous Plants

	Toxic Part	Effects of Ingestion
Flower garden plants		
Autumn crocus *Colchicum autumnale*	All parts, especially corm	Vomiting and nervous excitement
*Castor bean *Ricinus communis*	Seeds	Fatal; one or two castor bean seeds are near the lethal dose for adults
Daffodil, Narcissus *Narcissus pseudonarcissus*	Bulb	Nausea, vomiting, dermatitis
Dieffenbachia, (dumb cane) *Dieffenbachia* (various)	All parts	Intense burning and irritation of the mouth and tongue; death can occur if the base of the tongue swells enough to block the air passage
Elephant's ear *Colocasia esculenta* Some philodendrons	All parts	Painful irritation of the lips, mouth, tongue and throat; dermatitis
*Foxglove *Digitalis purpurea*	Leaves	One of the sources of the drug digitalis, used to stimulate the heart; in large amounts the active principals cause dangerously irregular heartbeat and pulse, digestive upset (usually), and mental confusion; may be fatal
Hyacinth *Hyacinthus orientalis*	All parts, especially bulb	Nausea, vomiting, diarrhea
Iris *Iris* (various)	Underground stems, leaves	Severe, but not usually serious, digestive upset; dermatitis
Larkspur *Delphinium* (various)	Young plants and seeds	Digestive upset, nervous excitement, depression; may be fatal
Lily-of-the-Valley *Convallaria majalis*	Leaves, flowers	Irregular heartbeat and pulse, usually accompanied by digestive upset and mental confusion
Monkshood *Aconitum* (various)	All parts	Digestive upset and nervous excitement
*Oleander *Nerium oleander*	Leaves, branches	Extremely poisonous; affects the heart, produces severe digestive upset, and has caused death  *Nerium oleander*
Poinsettia *Euphorbia pulcherrima*	Leaves, flowers	Can be irritating to mouth and stomach; sometimes causes vomiting and nausea but usually produces no ill effects
Star-of-Bethlehem *Ornithogalum umbellatum*	Bulbs, flowers	Nausea, vomiting, intestinal disturbances

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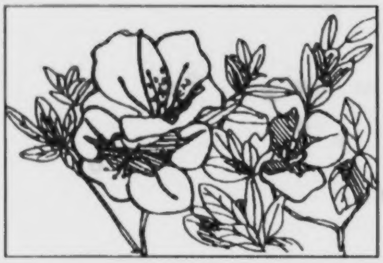
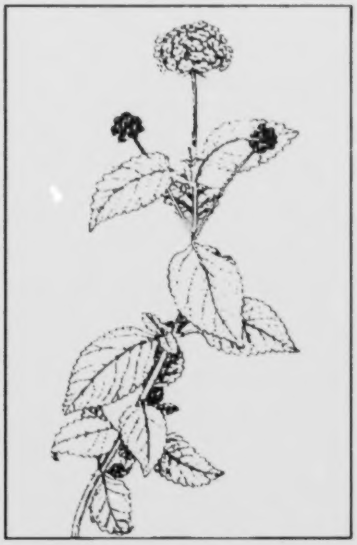
* Included in *Poisonous Plants of California* by Thomas C. Fuller and Elizabeth McClintock. Berkeley: University of California Press, 1987. The authors cite these 12 plants as frequently occurring seed plants that all Californians should learn to recognize.

TABLE 5 (Continued)

	Toxic Part	Effects of Ingestion
Ornamental plants		
*Angel's trumpet (red, white) *Brugmansia sanguinea*	All parts, especially seeds	Thirst, dryness of mouth and skin, flushing of face, visual disturbances, nausea, rapid pulse, fever, delirium, incoherence, stupor (depends on amount); effects may be immediate or delayed several hours
Azalea, western rhododendron *Rhododendron* (various)	All parts	Fatal; produces nausea and vomiting, depression, difficult breathing, prostration, and coma
Cherries, wild and cultivated Apricots *Prunus* (various)	Kernel inside hard pit	Fatal; contains a compound that releases cyanide when eaten; gasping, excitement, and prostration are common symptoms, often appearing within minutes
Daphne *Daphne* (various)	All parts, especially berries	Fatal; a few berries can kill a child
Golden chain *Laburnum anagyroides*	All parts	Severe poisoning; excitement, staggering, convulsions, and coma; may be fatal
Jessamine *Gelsemium sempervirens*	All parts	Fatal; digestive disturbance, nervous symptoms, impaired respiration, convulsions
Laurel, black/sierra *Leucothoe* (various)	All parts	Fatal; cardiovascular disturbances
Moonseed *Cocculus laurifolius*	Bark	Muscle relaxant, respiratory depression or arrest
Red sage *Lantana camara*	Green berries	Fatal; affects lungs, kidneys, heart, and nervous system



Rhododendron



Lantana camara

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* Included in *Poisonous Plants of California* by Thomas C. Fuller and Elizabeth McClintock.

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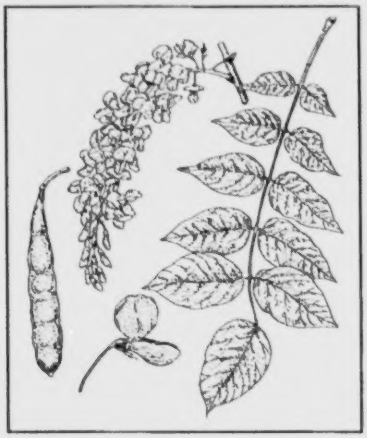
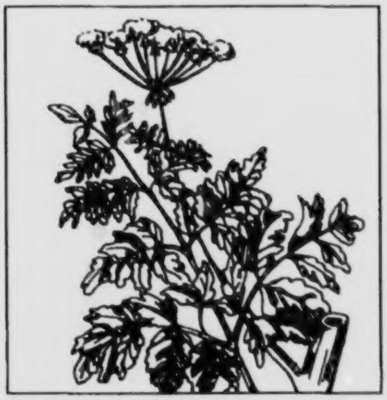
TABLE 5 (Continued)

	Toxic Part	Effects of Ingestion
Ornamental plants		
*Rosary pea *Abrus precatorius*	Seeds	Fatal; a single rosary pea has caused death; *not grown* in California but used in seed ornaments
Wisteria *Wisteria* (various)	All parts, especially seeds and pods	Mild to severe digestive upset; many children are poisoned by this plant  *Wisteria floribunda*
*Yew (English yew) *Taxus baccata*	Berries, foliage	Fatal; foliage more toxic than berries; death is usually sudden, without warning symptoms
Plants in fields		
Buttercup *Ranunculus* (various)	All parts	Irritant juices may severely injure the digestive system
*Jimsonweed (thorn apple) *Datura stramonium*	All parts	Abnormal thirst, distorted sight, delirium, incoherence, and coma; common cause of poisoning; has proved fatal
*Meadow death camas *Zigadenus venenosus*	All parts	Thirst, dizziness, headache, vomiting, slow heart action, low blood pressure, convulsions
Nightshade *Solanum* (various)	All parts, especially unripe berry	Fatal; intensive digestive disturbances and nervous symptoms
*Poison hemlock *Conium maculatum*	All parts	Fatal; resembles a large wild carrot; used in ancient Greece to kill condemned prisoners  *Conium maculatum*

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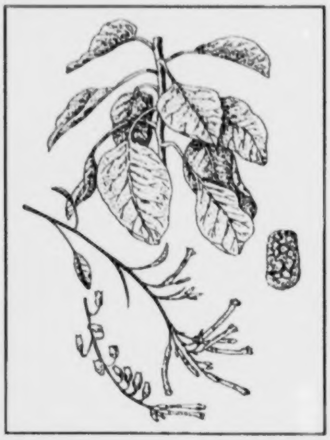
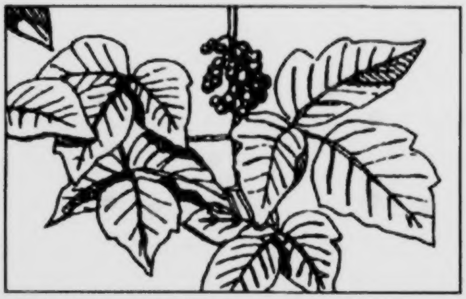
* Included in *Poisonous Plants of California* by Thomas C. Fuller and Elizabeth McClintock

TABLE 5 (Continued)

	Toxic Part	Effects of Ingestion
Plants in fields		
*Pokeweed *Phytolacca americana*	All parts	Thirst, coughing, vomiting, diarrhea, severe dehydration, shock; rarely fatal
*Tree tobacco *Nicotiana glauca*	All parts	Fatal; nausea, vomiting, diarrhea, respiratory paralysis
Plants in swamp or moist areas		
*Western water hemlock (central and northern California) *Cicuta douglasii*	All parts	Fatal; violent and painful convulsions; a number of people have died from hemlock
Plants in wooded areas		
Black locust *Robinia pseudoacacia*	Bark, sprouts, foliage, seeds	Causes nausea, weakness, and depression in children after they chew the bark and seeds
Elderberry *Sambucus* (various)	Shoots, leaves	Children are poisoned by using pieces of the pithy stems for blowguns; nausea and digestive upset
Mistletoe *Phoradendron* (various)	All parts, especially berries	Fatal; children and adults have died from eating the berries
Oak *Quercus* (various)	Foliage, acorns	Affects kidneys gradually; symptoms appear only after several days or weeks; takes large amount for poisoning; do not allow children to chew on acorns
Poison oak, Pacific poison oak Western poison oak *Toxicodendron diversilobum* *[Rhus diversiloba]*	Leaves, stems, berries, roots	Skin contact with oily fluid secreted in all parts of plant causes painful, often long-lasting skin eruptions and a burning, itching sensation
Vegetable garden plants		
Rhubarb *Rheum rha barbarum*	Leaf blade	Fatal; large amounts of raw or cooked leaves can cause convulsions and coma, followed rapidly by death


Nicotiana glauca


Toxicodendron diversilobum
[Rhus diversiloba]

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* Included in *Poisonous Plants of California* by Thomas C. Fuller and Elizabeth McClintock.

G Ionizing Radiation

Before considering the acquisition of radiation-producing machines or radioactive materials, school administrators and science department faculty should obtain a copy of the California Radiation Control Regulations (*California Code of Regulations, Title 17*). The manual is available from the California Department of Health Services, Radiologic Health Branch, P.O. Box 1525, Sacramento, CA 95807. It provides regulatory, licensing, and safety requirements for the use of radiation-producing machines and radioactive materials.

When planning to use radiation-producing machines or radioactive materials in the classroom, teaching and administrative staff should be fully aware of the recommendations of the National Committee on Radiation Protection and Measurements and of the requirements of *California Code of Regulations, Title 17*, Section 30265, that limit radiation exposure of persons under eighteen years of age to no more than 0.5 rem per year. Although the risk of reaching or exceeding that limit is exceedingly small, all uses should be planned and conducted accordingly.

Schools should not accept gifts of X-ray machines or radioactive materials until (1) the machines have been checked by a qualified health physicist or radiological physicist to determine that the equipment can be operated safely and without excessive radiation leakage; and (2) the radioactive materials have been determined not to exceed permissible quantity limits specified by *California Code of Regulations, Title 17*, Section 30180(c), and have been found to be free of removable contamination in excess of 0.005 microcurie.

Radiation Machines

A radiation machine is any device capable of producing ionizing radiation when the associated control devices are operated. Examples of radiation-producing machines are medical and dental machines used in the healing arts, electron microscopes, cabinet X-ray machines, and fluoroscopes.

Registration. Every person who acquires a radiation-producing machine shall register it with the Department of Health Services (DOHS) within 30 days. Registration forms can be obtained from DOHS, Radiologic Health Branch, P.O. Box 1525, Sacramento, CA 95807; telephone (916) 445-6256.

Exemptions. Electrical equipment is exempt from registration if it produces radiation incidental to its operation but does not produce radiation in any accessible area to such a degree that an individual will be likely to receive a radiation dose to the whole body or to the head, trunk, gonads, lens of the eye, or active blood-forming organs in excess of 0.5 rem in a year. Examples of potentially hazardous equipment are flyback transformers, shunt regulator tubes, and cathode-ray tubes operating at voltages in excess of 20,000 volts.

Cold Cathode-Ray Tubes

Cold cathode-ray tubes of the types commonly used in the classroom have been identified as potential sources of hazardous X rays coincidental to the intended use of the tubes. The information in this section on cold cathode-ray tubes was provided by the California Department of Public Health in Berkeley as a guide for science teachers.

Cold cathode-ray tubes are used for the study of electrons and electronic phenomena. The tubes come in a multitude of sizes, shapes, and forms. Three kinds of cold cathode-ray tubes that can produce potentially hazardous X rays coincidental to their intended use are heat-effect tubes, magnetic-effect tubes, and shadow- or fluorescence-effect tubes. These cathode-ray tubes can produce X rays when all the following conditions are met:

- An electron source or cathode is present.
- There is a target or anode that the electrons can strike.
- A high potential difference exists between anode and cathode. (In voltage of 10KV or under, the electrons do not acquire sufficient energy to produce significant X rays.)
- Low gas pressure prevails between cathode and anode; that is, a moderately good vacuum exists in the tube.

The *heat-effect tube* is used to demonstrate that cathode rays consist of rapidly moving electrons whose kinetic energy is converted to heat on collision with an object. The tube consists of an evacuated glass bulb with a thin foil target positioned between opposed electrodes. The cathode has a concave surface to focus electrons on a small spot of the foil. The focal spot on the foil can easily be heated to a dramatically visible white heat.

The *magnetic-* or *deflection-effect tube* demonstrates that cathode rays carry an electric charge and can be deflected by a magnetic field. This tube consists of an evacuated glass cylinder with an electrode at each end. An aluminum strip coated with a fluorescent material is positioned between the electrodes, and a collimating slit is at the cathode end. In a magnetic field the luminous line caused by electron bombardment of the fluorescent strip moves up or down according to the polarity of the magnet.

The *shadow-* or *fluorescence-effect tube* demonstrates that cathode-ray energy may be converted into visible radiation by fluorescence of the glass walls of the tube, resulting from electron bombardment. A metallic object, such as a Maltese cross, is placed in a Crookes tube so that its shadow can be cast on the glass wall of the tube. By observing this shadow, one can see that the cathode rays producing this pattern travel in straight lines.

The following conclusions may be drawn about X-ray production from the cathode-ray tubes:

1. X-ray output is sporadic. Under identical conditions of operation, output may vary from one tube to another or from the same tube from day to day.
2. Gas pressure within the tube is one of the controlling factors in X-ray production. If there is sufficient gas present, the accelerated electrons will collide with gas atoms and, therefore, never gain enough energy to produce X rays.
3. Tube composition plays an important part in producing X rays. X-ray production is a function of the target materials that the electrons strike.
4. The tube wall, if thick enough and of proper composition, can act as a shield for X rays.
5. The output of the tube is strongly dependent on the voltage and current capabilities of the power source.

The Department of Health recommends the following procedures in the use of cold cathode-ray tubes:

- Tubes should be used only for demonstrations conducted by the instructor.
- Tubes should always be operated at the lowest possible current and voltage, and the time of operation should be kept to a minimum.
- No student should stand closer than 10 feet (3 m) from a tube when the tube is in operation.

Radioactive Materials

This section applies to situations in which individuals or groups actively participate in investigations or projects involving the use of radioactive materials. It does not refer to class demonstrations of the use of radiation detectors or cloud chambers.

The properties of radioactive materials have numerous applications in scientific research, medicine, and industry. These applications are anticipated not only to continue but also to increase dramatically in number and in kind. School district science programs should provide students with an opportunity to investigate radiological theory and the uses of radioactive materials to develop techniques and skills in handling such materials safely.

Licenses. California Code of Regulations, Title 17, states the conditions under which persons and institutions may possess and use radioactive materials: either a school must have and use only small (exempt) quantities and concentrations of radioactive materials or the school must have a specific license to possess and use radioactive materials. The terms are described below:

- Possession or use of exempt quantities and concentrations of materials, as defined in *California Code of Regulations, Title 17,* Section 30180, does not require the issuance of a specific license. Exempt materials include (a) any naturally occurring radioactive material (except uranium and thorium); (b) unprocessed ore which, in its natural form, contains uranium and thorium; (c) radioactive materials in concentrations that do not exceed those noted in Schedule C of *Title 17;* and (d) radioactive materials, provided that the quantity of each material does not exceed the applicable quantity noted in Schedule A of *Title 17* and provided that not more than ten such quantities are possessed at any one time.
- Specific licenses, as defined in *California Code of Regulations, Title 17,* sections 30194 and 30195, are required if an individual or an institution intends to possess or use quantities or concentrations of radioactive materials in excess of the amounts specified in schedules A and C. Information relating to specific licenses can be obtained from the Department of Health Services, Radiologic Health Branch, 714 P Street, Sacramento, CA 95814. Applications for specific licenses must be signed by an appropriate school district staff member, who has the responsibility for ensuring that the radioactive material is used and stored safely. The direct responsibility for safe use and storage rests with an appropriately trained radiation safety officer at the site of use. Both persons must be designated on the license application.

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Strict compliance with the conditions attached to specific licenses is required for approval of the licenses. An amendment request must be submitted for any change in the personnel using radioactive materials, the radiation safety officer, or the site of use. A copy of the license must be maintained in the school district staff offices as well as at the site of use. All persons at the site of use must be aware that they have access to the license and its conditions as well as to laws and regulations set forth in the *California Penal Code* and the *Health and Safety Code*.

Procurement and storage of radioisotopes. Before the first procurement of radioactive materials, the school should make certain that a radiation survey meter is available. The recommended type of radiation detection instrument is an end window Geiger-Mueller (G-M) detector with a detection window of approximately 2 mg/cm^2. When used properly, this instrument will detect alpha, beta, and gamma radiation. G-M detectors are available at relatively low cost; assistance in choosing the correct instrument can be provided by DOHS or a competent health physicist.

Orders for procurement of radioisotopes, whether in exempt amounts or as allowed by specific license, must be approved by the appropriate school-site administrator and school district staff member. On receipt of the material, the teacher or designated radiation safety officer (RSO) must take the following steps:

- Carefully inspect the package for damage before opening it.
- If there is no damage, open the package, inspect the contents, and compare the contents with the packing slip.
- If there are any indications of external damage or contamination of the packing material or if the contents do not match the packing slip, notify the vendor immediately and request disposal instructions. In the interim place the package and contents in a plastic bag, seal and store the bag, and monitor the storage area for contamination.

All schools in which radioactive materials are used must provide a secure storage location. The location must be kept locked when not in use, and access must be limited to designated persons only. The room must be properly posted and accurate records maintained of each isotope or source. Records must include the type and quantity of isotope, date of assay, date of receipt, and usage information. No more than ten scheduled quantities of isotopes may be stored in any one school, as specified in the California Radiation Control Regulations *(California Code of Regulations, Title 17).*

Use of radioisotopes. The use of radioactive materials in classroom activities can provide valuable experience in preparation for subsequent vocational or university application. However, the use should be closely supervised. The standard radiation symbol with the words *Caution—Radioactive Material* should be displayed both at the storage room and in the classroom when the isotopes are in use. Normally, the use of film badges or other types of radiation dosimeters is not required when using exempt quantities of radioisotopes. However, an operable radiation survey meter should always be available and should be used following the classroom exercise to verify that there is no contamination on the hands or body or on surfaces that have come into direct contact with the isotopes.

Observance of the following rules will ensure that radioisotopes are used safely:

- Never handle radioactive sources with unprotected fingertips. The use of forceps or tongs will minimize exposure to the hands and fingers.
- Alpha emitters can be shielded easily by a sheet of paper; beta emitters should be shielded by one-quarter-inch lucite or glass. However, teachers should remember that both of these sources are often accompanied by the emission of gamma rays, which may require lead shielding. Exempt gamma-emitting sources can usually be shielded easily by one-quarter-inch lead.
- No experiments should be performed that might cause the release of gaseous radioactive products, nor should radioactive materials be disposed of in sinks and drains or unmarked waste or trash containers.

Disposal of unneeded radioactive materials. When teachers and administrators become aware of the presence of radioactive sources and materials that are the remains of old classroom activities, they should never dispose of those materials as ordinary trash. Usually, the materials are partially or completely decayed. The only acceptable methods of removal are by disposal as radioactive waste or by transfer to a person or institution holding a specific license authorizing receipt of the material.

Disposal as radioactive waste presents unique but not unsolvable problems. Radioactive sources and trash must be kept separate from liquid materials, which must be absorbed against diatomaceous earth or a similar agent. Both must be packaged in steel drums, manifests must be prepared, and the material must be transferred to an authorized disposal company. Before that is done, the school must have an EPA number (see Chapter 5, section E, step 5; and the regulations in Appendix B, dealing with "milkrun operations" for transporting hazardous waste) and a permit from one of the three states that maintain low-level waste disposal sites. (The same EPA number can be used for disposal of chemicals and other hazardous materials.) The DOHS maintains a list of licensed waste-disposal companies; those companies will offer assistance with obtaining the necessary permits and licenses.

An acceptable and less costly method of disposal of unwanted radioisotopes is by transfer to a specific licensee. Inquire of nearby universities, colleges, and research organizations whether any has a license for the particular type and quantity of material that you wish to dispose of. Disposal can usually be done for a minimal cost. The designated school district staff member or radiation safety officer is responsible for first obtaining a copy of the receiver's license to verify that it includes the material in question. Then the designated person is responsible for packaging the material for shipment or transfer, complying with other reasonable requirements of the receiver, and obtaining a receipt for the material.

The disposal process or transfer to a licensee must be coordinated with the appropriate school or school district staff. If the material to be disposed of or transferred is material for which the school holds a license and the intent is to abandon the license, the DOHS must be notified of such intent. A final inspection will be conducted by that agency.

H Earthquake Preparation

Earthquake! A strong shake measuring 6.5 on the Richter scale smashes all the glass containers in the chemical storage area, allowing the chemicals to intermix and releasing toxic fumes and a corrosive slurry strong enough to eat through the flooring and cement.

That scenario may sound unreasonable, but it happened at Coalinga High School in 1983. Consultant E. Robert Bulman concludes in his report, "The Coalinga Earthquake: A Report on Schools," that although California's school buildings can structurally withstand an earthquake of magnitude 6.5, the shaking will cause a tremendous amount of glass breakage. He recommends the following preventive measures: (a) toxic chemicals must be stored on low shelves and in chemical-proof pans; (b) the floor must be acid-proof; (c) the school must keep an inventory of what is in the storeroom; (d) the name of the nearest chemical burn center should be posted in the chemistry laboratory; and (e) disaster drills must be conducted more frequently. (See also Chapter 5, section E, "Steps for Establishing a Safer Chemicals Storage Area.")

The experiences of Jack Grube, who was administering school science programs in the earthquake-damaged areas during both the magnitude 6.9 earthquake in the San Francisco Bay Area on October 17, 1989, and the 6.8 earthquake in Northridge, California, on January 17, 1994, demonstrate the importance of preparedness. He found that science preparation areas that are properly managed and have good storage practices can ride out strong earthquakes. There was no damage to the contents of shelving that was secured to the wall and had retaining lips on the front edge. However, doors on storage cabinets did not protect the contents as well as the secured shelves did because lateral motion was able to throw doors open unless they were securely (purposefully) latched. He concludes that (a) earthquake procedures and drills should specifically address the dangers of science storage areas; (b) science teachers (and facilities) should be prepared for emergencies and should be called on to supervise cleanup after an earthquake, rather than custodial and other inadequately trained personnel; and (c) battery-operated emergency lights should clearly illuminate chemical storage areas.

The following sobering statement was made by the Bay Area Regional Earthquake Preparedness Project (BAREPP) in 1985:

> Approximately 80 percent of California's population is located within the Uniform Building Code's highest seismic risk zone out of the five zones in the United States. The remainder of the state is located in the next highest zone. This translates to virtually a 100 percent chance of experiencing light shaking or worse during (the next) 25 years.

As urban areas in the vicinity of hazardous earthquake regions become increasingly populated, the amount of death and destruction from earthquakes can be expected to rise. Therefore, California's science teachers need to prepare now. Instructors should read this entire section on seismic safety, then act. The earthquake safety measures outlined in this section are intended to augment the school's general emergency/disaster plans.

The central components of any earthquake-response plan for seismic safety in science classes should include, but not be limited to, the following phases:

1. Surveying the classroom and stockroom for nonstructural hazards
2. Performing hazard-reduction projects
3. Creating an earthquake-response plan
4. Procuring emergency equipment and supplies

Completion of these four phases will help the school come into compliance with the requirements of the law to establish earthquake emergency procedures (*Education Code* sections 35295 through 35297 and 40041.5; see Appendix B).

Phase 1: Nonstructural Hazard Identification

The following checklist is intended to help identify common nonstructural earthquake hazards that can be reduced or eliminated at little or no cost. For questions checked *No,* refer to Phase 2, step three, of this section, which contains suggestions for rectifying nonstructural hazards.

		Yes	*No*
1.	*Equipment/furnishings/fixtures*		
a.	Are freestanding cabinets, lockers, bookcases, cupboards, storage racks, and wall shelves secured to a structural support?	☐	☐
*b.	Are the ceilings, overhead lights, movie screens, and air ducts secured to a structural support?	☐	☐
c.	Do tall industrial storage racks have adequate bracing?	☐	☐
d.	Are racks that are significantly taller than they are wide connected to the concrete slab by large anchor bolts?	☐	☐
e.	Is the television monitor securely fastened either to a securely fastened platform or to a cart with a low center of gravity and lockable wheels?	☐	☐
f.	Do desktop computers have secured monitors?	☐	☐
g.	Are heavy or sharp wall decorations securely mounted (with closed eye hooks, for example)?	☐	☐
h.	Have heavy objects stored above head level been restrained or relocated?	☐	☐
*i.	Are refrigerators, water heaters, or ranges restrained by attachment to the floor or wall, not just by kitchen cabinetry?	☐	☐
j.	Is specialized heavy laboratory equipment (e.g., an autoclave) on a countertop secured to protect it against sliding off and falling?	☐	☐
k.	Are fire extinguishers securely mounted?	☐	☐
l.	Are cabinets equipped with heavy-duty latches? (Magnetic catches can pop open too easily.)	☐	☐
m.	Are display cases or aquariums protected against overturning or sliding off tables?	☐	☐
n.	Are emergency battery-operated lights protected from falling off shelf supports?	☐	☐
*o.	Are the fire-sprinkler risers secured to the wall with a vee brace, and are large-diameter sprinkler pipes secured with diagonal braces to the structure above (see NFPA Standard Number 13)?	☐	☐

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*Additional help from the janitor or maintenance person may be needed.

*p. Do sound-system speakers in elevated locations have positive anchorages? ☐ ☐

*q. Are suspended space heaters, especially gas-fired heaters, braced and/or equipped with flexible gas connections? ☐ ☐

r. Are hanging plants, movie screens, or displays fastened with closed eye hooks and positioned so that they would not hit a window if they were to swing? ☐ ☐

*s. Are air-distribution grills or diffusers screwed to adequately supported sheet metal ducts or to the ceiling or wall? ☐ ☐

*t. Are large metal air-distribution ducts, especially those that are suspended a few feet, fastened with diagonal bracing? ☐ ☐

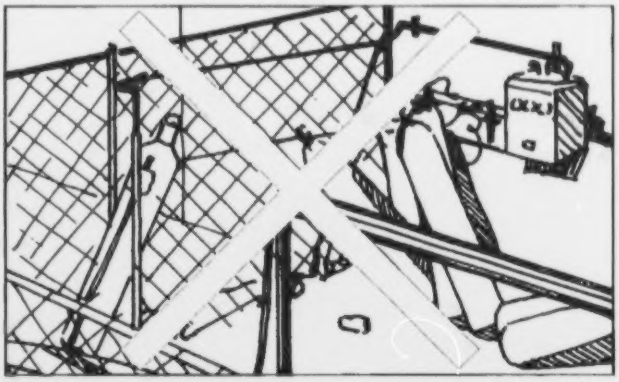
*u. Is the suspended ceiling equipped with bracing wires? (See *Uniform Building Code* [UBC], Table 23-3, and UBC Standard 47-18.) ☐ ☐

*v. Are the lay-in fluorescent light fixtures independently supported by at least two hanger wires per light fixture? ☐ ☐

2. *Hazardous/toxic materials*

a. Have inventories been made of hazardous chemicals so that someone can check the chemicals after an earthquake? ☐ ☐

b. Are compressed gas cylinders tightly secured with a nylon strap or strong chain near the top and near the bottom or stored on a rack designed to restrain cylinders? ☐ ☐



c. Are laboratory chemicals on shelves restrained by a wire, lip, or other barrier? ☐ ☐

d. Have chemicals been stored by compatible groups to reduce the likelihood of their mixing and causing reactions? ☐ ☐

e. Have chemicals been stored in plastic or other unbreakable storage containers? ☐ ☐

*f. Does gas piping allow for movement at connections to equipment that could slide, swing, or tip or at points where the piping crosses expansion joints structurally separating the wings of a building? ☐ ☐

*g. Are automatic gas shut-off devices that are sensitive to excess flow designed to be actuated by leak detectors or triggered by earthquakes? ☐ ☐

3. **Windows*. Have the windows in the classroom/laboratory or stockroom been equipped with safety glass or covered with protective film? ☐ ☐

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*Additional help from the janitor or maintenance person may be needed.

Phase 2: Hazard Reduction Projects

After identifying the nonstructural hazards in your classroom, laboratory, stockroom, and preparation room, you need to determine the most effective method to mitigate those risks.

Step one. Establish an earthquake awareness program.

Central to earthquake preparedness is the earthquake drill to teach students (and staff) how to *respond immediately* with life-protecting action. The procedures for earthquake drills in science instructional areas need to be individualized for each room at each site; however, the following elements would be similar for all:

- Duck, cover, and hold. (Students duck under their desks or tables, cover their neck and head, and hold on to a table leg.)
- Guard against potential hazards:
    - Extinguish flames.
    - Unplug electric cords.
    - Secure apparatus. (Perhaps, set them in sinks or on the floor.)
    - Shut off water, gas, and electricity master controls.
    - Have fire extinguishers at ready.
- Evacuate to an open area when necessary or safe to do so (instructor's decision).
- Comply with administrative instructions.

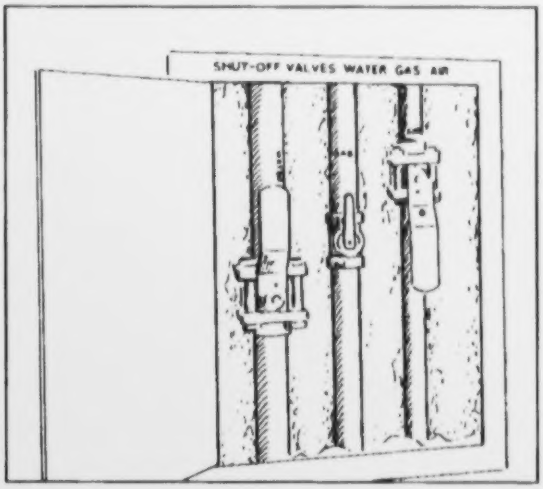
The activities in this list are not necessarily in a set order. In an emergency the severity of the earthquake will help dictate the order. If any of the actions to guard against hazards can be accomplished in the process of "duck, cover, and hold," the situation would become much safer.

Advance preparation for the drill and for a sizable earthquake emergency will facilitate each step. Teachers should lead students in each class through a simulated drill early in the course and repeat the drill occasionally during the year. This practice should carry over to staff preparation and response at home and wherever else one may be during a real emergency.

A simulated drill is also the time in which to correct deficiencies in the preparedness of the facility. Identify objects, structures, and furnishings that should be avoided and those that might be used for protection. Objects, glassware, instruments, or books that are on shelves without earthquake lips (even those on shelves with closed doors) are likely to dislodge and fall or become missiles. Objects (including containers of chemicals and solutions) standing on counters will likely fall to the floor. Anything that can be used as a cover (tables, chairs, books) to provide protection from falling ceiling tiles or other objects will decrease the likelihood of injury.

Each drill should be followed by an evaluation, including the assessment of any hazardous condition that should have been corrected. The follow-up discussion should not only reinforce the idea of *where* to seek shelter and *how* to protect oneself but also provide a forum in which students can voice their concerns, thus minimizing the possibility of panic if an earthquake does occur.

In addition, science staff should take the time to evaluate the preparedness of the entire department and go through each room to estimate the consequences of a severe earthquake at any given moment. This action should lead to continual improvement in the preparedness of basic structures as well as improved housekeeping procedures.


SHUT-OFF VALVES WATER GAS AIR

Step two. Obtain or draw a map of the school and school grounds. Use the map to note potential hazards and to mark the location of utilities, emergency equipment, and supplies. Be sure to mark the locations of the following items:

- Main shut-off valves for water and gas
- Electrical-power master switch
- Stoves and heating/air-conditioning equipment
- Chemical storage areas and gas lines in laboratories
- Fire extinguishers
- First-aid equipment

The map can also be used as the basis for (a) tracing an evacuation route; (b) locating a safe assembly area; and (c) creating an earthquake-response plan (e.g., planning first-aid and search-and-rescue strategies).

Step three. Mitigate the nonstructural hazards.

The following methods are suggested to rectify the hazards that were identified in Phase 1 (a checklist of the more common nonstructural hazards found in secondary science classrooms). Each suggestion is cross-referenced to items in Phase 1.

1. Equipment/furnishings/fixtures
    - a. Anchor all file cabinets, shelving, and bookcases to wall studs. (*Phase 1: 1.a, 1.c,* and *1.d*)
    - b. Check cupboards and cabinets for secure latches that would stay locked during an earthquake. (*1.l*)
    - c. Anchor all desktop computers and their components, televisions, aquariums, plants, sound systems, lamps, and other heavy items. (*1.e, 1.f, 1.i,* and *1.m*)
    - d. Remove or secure any boxes or equipment stored on top of high cabinets. (*1.h*)
    - *e. Check the secure attachment of any *overhead* fixtures, decorations, lighting, grills in walls, ceiling panels, or latticework. (*1.b, 1.g,* and *1.n* through *1.v*)
    - *f. Securely affix fire extinguishers in accessible areas. (*1.k*)
    - g. Put chocks under wheels of objects or wheels that lack built-in brakes. (*1.e* and *1.i*)
    - *h. Restrain heavy equipment (e.g., refrigerators, ranges). (*1.i* and *1.j*)
    - i. Post safety signs, symbols, and labels to reinforce safety precautions.
2. Hazardous/toxic materials
    - a. Secure compressed gas cylinders or large tanks with strong nylon straps or heavy-duty chains. (*2.b*)
    - b. Use wires or other barriers to restrain objects from falling from open shelving. (*1.l* and *2.c*)
    - c. Store chemicals in unbreakable containers and in accordance with the compatibility system prescribed in this handbook (see Chapter 5, section E, step 7), or a similar system, to reduce the possible occurrence of incompatible mixtures. (*2.d* and *2.e*)
3. Windows

    If the windows are not made of safety glass, a protective, transparent film may be applied to reduce the danger of flying glass and provide an additional security measure against break-ins. *(3)*

Phase 3: Emergency Response Plan (ERP)

In response to the Statutes of 1984, Chapter 1659 (see relevant *Education Code* sections in Appendix B), most schools have already developed an earthquake emergency procedure system that includes, but is not limited to, the following:

- A school-building disaster plan
- A "duck, cover, and hold" drill (students duck under their desks, cover their neck and head, and hold onto a leg of the desk)
- Protective measures to be taken before, during, and after an earthquake
- A training program for students and staff on the earthquake emergency procedure system

See Phase 2, step one, for more details on procedures specific to earthquake awareness in science instructional areas.

Schools should also have in their possession the excellent guide entitled *Guidebook for Developing a School Earthquake Program*, furnished a few years ago by the Federal Emergency Management Agency (FEMA).

Phase 4: Emergency Equipment and Supplies

The threat of an earthquake-related emergency varies considerably from one region of the state to another. However, the basic equipment and supplies that science laboratory/classroom personnel need to have on hand in the event of a severe earthquake are quite similar to those needed in other natural emergencies, such as fire, flood, or tornado, or in disasters resulting from air, railroad, or highway accidents. Furthermore, *Education Code* Section 40041.5 specifies that the school buildings, grounds, and equipment must be made available to the public agencies, including the American Red Cross, for mass care and welfare shelters during disasters or other emergencies (see Appendix B). It is advisable and prudent to consider such possibilities in the overall emergency planning. The most obvious needs would include the following:

---

*Additional help from the janitor or maintenance person may be needed.

- A source of lighting, such as a flashlight, with fresh batteries as well as spare batteries and bulbs
- A battery-powered radio for receiving information and instructions
- A well-stocked first-aid kit
- A generous supply of water

Science rooms already have available a number of safety features, including fire extinguishers, fire blanket, chemical spill-control kits, and eyewash stations. Because the science laboratory/classroom has the potential for the occurrence of unique injuries from flammable, toxic, and corrosive substances, consideration should be given to the possibility of tap water being unavailable. Additions to the list of emergency supplies might include these items:

- Sterile squeeze bottles and spray bottles, useful for applying water to burns or spills of toxic or corrosive substances on the skin or in the eye
- Extra water
- Extra fire blanket(s), both for the primary purpose of smothering fires and for maintaining body warmth during first-aid measures

A plan must be established for replacing components regularly to ensure that all items are fully available and functional at all times. During an emergency evacuation of the facility, the emergency supplies, as appropriate, should be a part of the orderly departure.

I Waste Reduction

The growing costs of the disposal of toxic waste and concern about the effects of toxic waste on humans and the environment make the reduction of waste generated by schools an increasingly important issue. By employing innovative strategies that effectively reduce the volume and toxicity of laboratory waste, schools and school districts will reap the benefits of (1) lower overall costs for waste disposal; (2) increased organization and safety in laboratory and storage areas; and (3) decreased amounts of chemical waste. Such efforts will also contribute to the efforts of each city and county to divert 25 percent of their solid waste from landfills by 1995 and 50 percent by 2000 through source reduction, recycling, and composting, as mandated by the *Public Resources Code* (Division 30, Section 41780).

A campuswide waste-management program that involves all departments, including those of art and photography, auto shop, agriculture, and maintenance operations, provides the district with even greater cost savings in waste reduction. Pointing out to students, faculty, administrators, and maintenance staff the benefits of reducing their personal exposure to potentially hazardous chemicals is essential in obtaining campuswide commitment to the program. Vital information about worker safety can be solicited from industrial hygienists who work in local industries. And community businesses can provide professionals who will explain the advantages of source reduction. Once campuswide support for safety and reduction goals is established, the personal, fiscal, and ecological benefits will be evident almost immediately.

Assessment of Current Waste Policy

Before designing a waste-reduction plan, school authorities should perform an assessment of the school's current waste-generation sources and waste-management practices. Such an audit will provide insight into more effective waste-reduction methods and assist in planning and allocating resources toward the reduction of waste. Moreover, the audit will furnish data to use as a baseline in monitoring the progress of a waste-reduction plan. The assessment should be executed by knowledgeable staff members or specially trained consultants. Appraisal objectives should include the following:

- Identification of the types and amounts of hazardous materials used and the waste generated in each department
- Identification of significant losses of materials and the factors that cause the losses; for example, inaccurately measured amounts of substances used in experiments
- Suggested strategies for decreasing waste and stemming losses of materials
- Itemization of current waste-management costs and an estimate of the costs of proposed waste-reduction practices

When the assessment is complete, a flexible waste-reduction strategy can be generated.

Development of a Campuswide Plan

A campuswide waste-reduction plan should reflect changes in management practices as well as changes in everyday laboratory practices and the usage of chemicals.

Waste reduction through prudent management practices. The following management practices will help create a thorough and effective waste-reduction plan:

1. *Appoint a waste-management coordinator.* Select a trained faculty member who has been accredited through a college program or workshop on waste management to implement an integrated waste-reduction program approved by the school board. A prime responsibility of the waste-management coordinator would be to ensure that the school is in compliance with current local, state, and federal waste-management regulations.
2. *Provide employees with information about waste reduction.* To enhance schoolwide awareness and participation, inform employees of the necessity of waste reduction and the ways in which it can be achieved. Hands-on experiences provide the most effective learning forum for faculty and staff. Arrange follow-up meetings within each department to give all employees the opportunity to discuss and critique the effectiveness of their reduction efforts.
3. *Centralize purchasing.* Schools should consider developing a system for buying chemicals through a centralized district or consortium purchasing agent. The purchaser would monitor all requests received from the entire district or consortium and place money-saving bulk orders for chemicals, then distribute the chemicals to the schools.
4. *Prevent overstocking.* Within each school, teachers can prevent overstocking and ensure the availability of fully potent chemicals by sharing chemicals among common users and buying chemicals only as needed. A practice that is initially slightly more expensive (but will save money in the long run) is the purchase of a chemical in several small bottles. This system helps to stem the loss of large amounts of a chemical reagent through accidental contamination and makes it easier to manage unused amounts. Another successful cost-cutting strategy is to estimate the amount of a chemical reagent the school (all departments) will use in one year and order only that amount at the beginning of the year. Bulk ordering for multiple years of predicted use is discouraged. Although a school may seem to take advantage of unit cost savings by ordering large quantities, there is often no net savings for the school because of the ever-increasing cost of disposal of outdated, unused chemicals.
5. *Choose a responsible vendor.* Schools can encourage better customer service from chemical suppliers by ordering supplies from those who provide quick delivery, accept the return of unopened stock, and offer off-site waste-management outlets or cooperatives for laboratory waste. These customer service benefits should be solicited from company representatives *before* orders are placed and should be considered as the basis for future orders.
6. *Establish an inventory control program.* An inventory control program should be established to trace the volume of waste generated. The inventory would enable more accurate tracking of all incoming chemicals from the time they arrive until they are disposed of as hazardous waste. Improved access to accurate inventory lists by all authorized district and school personnel will enable the sharing of chemicals between common users, provide data on all courses in which potentially hazardous chemicals are utilized, allow instructors to track the consumption of the chemicals they use and locate unused reagents, and allow the monitoring of the shelf life of chemicals. The program could be implemented on either the district or individual school level by means of a computer database and specialized software or a standard filing system.

Waste reduction through everyday laboratory practices, proper equipment, and experimental design. Although waste audits and up-to-date waste-management practices are essential to a campuswide waste-reduction program, the full cooperation and understanding of laboratory instructors are necessary if the program is to achieve success. According to the *Waste Audit Study of Research and Educational Institutions,* prepared for the California Department of Health Services' Toxic Substances Control Division (now the Department of Toxic Substances Control), schools can markedly minimize waste generation by taking the following actions in the laboratory:

Before the laboratory experiment

1. *Perform regular inspections.* By regularly inspecting all containers, the instructor can quickly replace those that are cracked or broken and so prevent spills and leaks.

2. *Preweigh materials.* After students master the skill of using the balance to weigh substances, it may be practical to preweigh materials for them. Students' laboratory productivity can be increased by reducing the time spent waiting for each student to weigh his or her materials. Preweighing chemicals also helps to prevent the contamination of substances, a problem that becomes more likely when many people are obtaining samples from the same bottle. Trained and properly supervised laboratory assistants who have reviewed the pertinent MSDS for each hazardous substance to be handled may perform the preweighing tasks.
3. *Use less-hazardous chemicals.* Substituting less-hazardous chemicals for chemicals that present health and environmental risks can reduce the use of more harmful chemicals. A reference on this strategy is *New Chemicals for Old, Preserving the Student Lab Experiment,* by R. Benedict (Minnesota Department of Education, 1987).
4. *Reduce metal-bearing waste.* Experiments that generate metal-bearing waste can be expensive because of the high cost of the processing treatments for heavy metals. Any commingling of less-hazardous waste with heavy metals causes the entire mixture to be classified as a heavy-metal waste and greatly increases the cost of disposal. Many heavy metals, such as hexavalent chromium, have recently been placed on the list titled "Extremely Hazardous Chemicals for Prompt Disposal" because of their carcinogenic or toxic nature (see Chapter 5, Table 2, of this handbook). Therefore, experiments that call for their use should be either modified or removed from the laboratory curriculum. Experiments that generate heavy metals should be carefully monitored so that waste streams are not mixed. If nonmetallic reagents are substituted for those containing metals, the district will probably encounter lower disposal costs.

During the laboratory experiment

1. *Use efficient dispensers.* Using containers that dispense their contents through pumps and spigots will reduce the likelihood of spills and measurement errors.
2. *Reduce wet chemistry.* In some circumstances the use of instrument methods instead of wet-chemistry procedures will help in reducing waste because instrument analysis requires much smaller quantities of chemicals.
3. *Avoid generating waste.* Sometimes chemicals can be rendered "sewerable" in the final steps of an experiment. In that case the process will not only reduce the need for off-site disposal but also increase students' awareness of proper waste management and waste reduction. A thorough reference on this strategy is *Prudent Practices for Disposal of Chemicals from Laboratories* (Washington, D.C.: National Academy Press, 1983), Chapters 5 and 6.
4. *Scale-down experiments.* The volume of chemicals used in experiments can be reduced by practicing microscale chemistry (described in the following subsection).

After the laboratory experiment

1. *Recycle experimental products.* Recycling chemicals by using the product of one experiment in the student's next experiment is an effective way greatly to diminish the amounts of fresh chemicals used in the laboratory. An entire college-level laboratory curriculum that focuses on using cyclic experiments is presented in *The No Waste Lab Manual: A Procedure That Eliminates Toxic Waste Production from Introductory Chemistry Laboratory Courses* (California Department of Health Services, 1989).
2. *Clean containers according to state regulations.* Costly disposal fees may be reduced by thoroughly emptying all used chemical containers. *California Code of Regulations, Title 22,* Section 66261.7, addresses the handling of contaminated containers and encourages recycling and other options for disposal of "empty" containers. Containers once filled with hazardous waste can be disposed of as nonhazardous waste *provided certain stipulations are met.* See Appendix T for definitions of empty containers and disposal options.
3. *Reuse solvents.* Use spent solvents for the initial cleaning of glassware; use fresh solvent only for the final rinsing.

Waste reduction through microscale chemistry. One of the most effective ways in which to achieve waste reduction is by using smaller volumes of chemicals to perform microscale laboratory experiments. In most microscale experiments the chemical quantities can be reduced to between one-tenth and one-thousandth of the usual scale. The main advantages of this approach include the following: (1) less money is spent on chemicals; (2) less waste is produced; (3) exposure to hazardous chemicals is reduced; (4) reduction in the volume of reagents for ecological and safety reasons can be modeled to students; and (5) the results of the experiment can often be determined more quickly.

The transformation of a laboratory from macroscale to microscale is easily accomplished. Some new materials must be purchased but these are relatively inexpensive. One cost-effective way of converting is to purchase reuseable plastic or polystyrene tissue-culture plates and plastic pipettes. Because water is the solvent used most often in high school experiments, the chemical stability of the plastic is not usually a problem. If plastic is unsuitable for organic chemistry, microscale glassware can be substituted, although it is slightly more expensive. Nearly all chemical suppliers now carry the equipment necessary for microscale experiments.

Several publications are available on experiments using microscale chemistry. Most focus on organic chemistry because minimization efforts are most cost-effective with those kinds of chemicals. Some reference books on the chemistry laboratory are as follows:

Mayo, D. W.; R. Pike; and S. S. Butcher. *Microscale Organic Laboratory* (Second edition). New York: John Wiley and Sons, 1989.

Microscale Experiments for the High School Chemistry Class. (Public domain experiments developed under an NSF- and Dreyfus-sponsored program.) Available from Woodrow Wilson Foundation, P.O. Box 642, Princeton, NJ 08542; telephone (609) 924-4666.

Mills, J. L., and M. D. Hampton. *Microscale Experiments for General Chemistry* (Second edition). New York: McGraw-Hill, Inc., 1991.

Thompson, S. *Chemtrek: Small-Scale Experiments for General Chemistry.* Englewood Cliffs, N.J.: Prentice Hall, 1990.

J Employees' Exposure to Hazardous Chemicals

Safety in school laboratories is a high priority to Cal/OSHA, as evidenced by the addition of laboratory standards issued in the *California Code of Regulations, Title 8,* Section 5191 (see Appendix B). That section of the law requires employers (e.g., school districts) to take specific action toward minimizing employees' exposure to hazardous chemicals. The following is a summary of the major changes in the standards (all sections cited here are from *California Code of Regulations, Title 8*):

Exposure Limits

The employer must ensure that an employee's exposure to substances regulated by Cal/OSHA does not exceed the exposure limits specified under "General Industry Safety Orders" (GISO), Section 5139.

Determination of Employees' Exposure

The employer must measure an employee's exposure to regulated substances if there is reason to believe that exposure levels for those substances exceed the action levels or permissible exposure limits (Section 5191 [c] and [d]). Monitoring must be done by a person competent in industrial hygiene practice and must occur periodically if the employee's exposure level proves to be over the action level or permissible exposure limit. The results of the monitoring must be made available to the employee in writing within 15 working days.

Chemical Hygiene Plan

If the workplace contains hazardous chemicals, employers should have developed and implemented a written chemical hygiene plan (CHP) by October 31, 1991. The purpose of the CHP is to protect employees from exposure to harmful levels of hazardous substances (Section 5191[e]). The plan must be made available to employees, employee representatives, and, on request, the Chief of the Division of Occupational Safety and Health and must provide for the following actions by the employer:

1. Provide standard laboratory operating procedures that are relevant to the safety and health of employees using hazardous chemicals.
2. Explain control measures that reduce employees' exposure to hazardous chemicals; for example, engineering controls, protective equipment, and hygiene practices.
3. Provide properly functioning fume hoods and biological safety cabinets that comply with sections 5154.1 and 5154.2 (see Appendix B) and check them regularly to ensure proper and adequate performance.
4. Provide each employee with information and training about the CHP and all hazardous chemicals in the workplace at the time of an employee's initial assignment and each time a new hazardous substance is used. The frequency of the presenta-

tion of refresher information and training must be decided by the employer (Section 5191[f]). The employer must inform all employees of the new regulations contained in Section 5191, the contents of the employer's CHP, the Cal/OSHA exposure limits for regulated substances, the recommended exposure limits for hazardous substances not regulated by Cal/OSHA, medical information on symptoms associated with exposure, and the location of references (e.g., MSDS) that provide information about the hazardous chemicals with which employees work. The employer must also provide training on methods used to detect the presence or release of hazardous chemicals, the hazards of each chemical used, and measures that can be taken to avoid exposure.

5. Define the circumstances under which particular laboratory operations require prior approval from the employer.
6. Provide free medical consultation and examinations on suspicion of exposure to hazardous substances (Section 5191[g]). The employer must obtain the written opinion of the physician about conditions of the employee relating *only* to the exposure.
7. Designate personnel responsible for the implementation of the CHP, including a chemical hygiene officer. The officer must be qualified by training or experience to provide guidance in developing and implementing the CHP.
8. Provide additional employee protection when particularly hazardous substances will be handled. *Note:* Substances on the list titled "Extremely Hazardous Chemicals for Prompt Disposal" (Table 2) should already have been removed from school laboratories.
9. Review and analyze the effectiveness of the CHP annually and update it as necessary.

A useful reference for developing a CHP for your school or school district is the *Model Chemical Hygiene Plan for Kentucky School Districts*, produced by Kentucky Science and Technology Council, Inc., the Kentucky Department of Education, and the Fayette County Public School District. Copies may be obtained for $10 each, plus shipping costs, from Kentucky Science and Technology Council, Inc., P.O. Box 1049, Lexington, KY 40588; telephone (606) 233-3502. The text is also available on disk for use with Macintosh or IBM-compatible computers.

Recordkeeping

The employer must establish and maintain accurate records and monitor employee exposures and examinations.

K Employees' Exposure to Bloodborne Pathogens

The *California Code of Regulations, Title 22*, Section 5193 (see excerpts in Appendix B), requires that each employer whose employees, in the course of their occupation, may be exposed to bloodborne pathogens must establish a written exposure control plan designed to eliminate or minimize such exposure. Selected school district employees may have such occupational exposure. The following material summarizes the regulation:

Background

Certain pathogenic organisms can be found in the blood of infected individuals and may be transmitted to other individuals by blood or certain body fluids. The human immunodeficiency virus (HIV) and the hepatitis B virus (HBV) are the two most significant bloodborne pathogens. Individuals whose occupational duties may expose them to blood or other potentially infectious materials are at risk of being infected with these bloodborne pathogens and developing disease, infecting others, and, in some cases, dying.

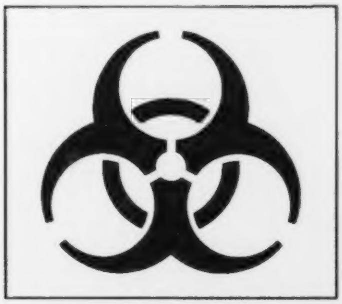
Exposure Control Plan

The written exposure control plan (ECP) must contain the following elements:

1. *Exposure Determination.* The employer shall maintain a list of all job classifications in which employees have or may have occupational exposure and a list of the tasks and procedures that place them at risk.
2. *Methods of Compliance.* Universal precautions shall be observed, as follows, to prevent contact with blood or other potentially infectious materials. If differentiation between types of body fluids is difficult, all shall be considered potentially infectious.
    - ***Engineering controls*** (for example, providing sharps-disposal containers with which to isolate or remove the hazard from the workplace) and ***work practice controls*** (dealing with handwashing; handling of sharps; eating,

drinking, smoking, and so forth in the work area; control of splashes and droplets; prohibition of mouth pipetting; leakproof containers; and labeling practices). These controls shall be established to eliminate or minimize employee exposure.

- ***Personal protective equipment,*** when occupational exposure exists. Personal protective equipment may include, but is not limited to, gloves, gowns, laboratory coats, face shields or masks, eye-protective devices, mouthpieces, resuscitation bags, pocket masks, and other ventilation devices.
- ***Housekeeping.*** The work site shall be maintained in a clean and sanitary condition; equipment and environmental and working surfaces shall be cleaned and decontaminated after exposure; and regulated waste shall be appropriately stored and disposed of. Warning labels in fluorescent orange or orange-red shall either be securely affixed to containers of regulated waste or be an integral part of the container. The label shall include the following symbol and legend:



BIOHAZARD

or, in the case of regulated waste, the legend:

BIOHAZARDOUS WASTE

Hepatitis B Virus Vaccination

After appropriate training and within 10 days of their initial working assignment, designated employees *shall be offered, at no cost to themselves,* vaccination against the hepatitis B virus. A record shall be kept of designated employees' acceptance or declination of the vaccine.

Postexposure Evaluation and Follow-up

All unvaccinated employees who have rendered assistance in any situation involving the presence of blood or other potentially infectious material, whether or not a specific exposure incident occurred, shall be offered vaccination against the hepatitis B virus. Incident reports shall be maintained about each such occurrence, and arrangements shall be made for a confidential medical evaluation, counseling, and appropriate postexposure prophylaxis.

Hazard Communication (Training)

All designated employees are to be trained at the time of their initial assignments and at least annually thereafter. The training is to include information on and an explanation of the following:

- The contents of the regulatory text and its accessibility to employees
- Bloodborne diseases and their modes of transmission
- The exposure control plan
- Recognition of tasks that may involve exposure
- Ways in which to prevent or reduce exposure
- Use and handling of protective equipment
- Appropriate action to be taken and procedures to be followed if an exposure incident occurs
- The availability, free of charge, of the hepatitis B vaccine
- Postexposure evaluation and follow-up

An opportunity for interactive questions and answers is also required.

Recordkeeping

The medical record of each designated employee shall include (1) the employee's hepatitis B vaccination status; (2) the results of related examinations, medical testing, and follow-up procedures; (3) copies of any health-care professional's written opinion or other information; (4) an incidents log of all first-aid incidents; and (5) the employee's training records.

The employee's medical records shall be kept confidential and maintained for at least the duration of employment plus 30 years. Training records shall be maintained for three years from the date on which the training occurred.

All required records shall be made available to the Chief of Cal/OSHA and the National Institute of Occupational Safety and Health (NIOSH) for examination and copying.

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Note: **Procedures discussed in this handbook involve potential dangers to persons, animals, and other living things and, therefore, should be performed only by persons who are technically trained and qualified.**

APPENDIX A

LIABILITY AND THE SCIENCE TEACHER

A Self-Examination

During the past few years, teacher liability has been discussed in faculty lounges, staff meetings, and professional journals. By now, most teachers are aware of the factors that contribute to gross negligence and thus to liability for accidents that occur in the classroom or the field.

In each of the cases described below, a science teacher was being sued for liability. As a member of the jury, would you judge these teachers guilty or not? Assume that the relevant facts have been given. Place a check in front of each case in which you would vote for a guilty verdict. The answers will be given below.

1. A biology teacher requested a student to bring a glass beaker from the back of the room to his demonstration table. The student slipped and fell and received serious wounds from the broken beaker.
2. A student in a chemistry laboratory injured himself while inserting a piece of glass tubing into a rubber stopper. The teacher had previously demonstrated and properly instructed all the students concerning the method and danger involved. The student attempted to force the glass tubing into the stopper and was injured when the tubing snapped and went through the palm of his hand.
3. During a physics lab a teacher stepped out of the classroom for a few minutes to obtain a reference book from the library. In his absence, a serious accident occurred.
4. On a field trip a science teacher led his students across a precarious-looking footbridge. The bridge collapsed, causing serious injury to several students.
5. A teacher asked two students to clean a chemical stockroom, warning them of an unlabeled jar of acid on a high shelf. A scuffle caused the acid to fall, and the students were seriously burned.
6. *A student was sent to the drugstore in his own car to* purchase some hydrogen peroxide. While returning, he hit another car when he ran a red light. He had no insurance, and the accident victim sued the teacher.
7. A student was asked to water the plants in the greenhouse lab adjoining the botany classroom. The student carried a glass full of water, tried to climb a chair, and was seriously injured when the chair collapsed. The chair was in good repair.
8. Three students in a chemistry class were making up a lab exercise on the preparation and properties of oxygen. The teacher told them to gather the materials necessary to the experiment and to follow the safety directions in the write-up. Contrary to the directions in the write-up, the students mixed potassium chlorate with red phosphorus and ferric oxide and heated them with a Bunsen burner. An explosion resulted, and several students were injured.

Answers: The jury voted guilty in numbers three; four; six; and eight. Did you?

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LIABILITY OF TEACHERS FOR LABORATORY SAFETY AND FIELD TRIPS

A National Science Teachers Association Position Statement

Laboratory investigations and field trips are essential to effective science instruction. Teachers should be encouraged to use these instructional techniques as physical on-site activity is important to the development of knowledge, concept, processes, skills, and scientific attitudes. Inherent in such physical activities is the potential for injury and possible resulting litigation. All such liability must be shared by both school districts and teachers, utilizing clearly defined safety procedures and a prudent insurance plan. The National Science Teachers Association (NSTA) recommends that school districts and teachers adhere to the following guidelines:

I. School districts should develop and implement safety procedures for laboratory investigations and field trips.

II. School districts should be responsible for the actions of their teachers and be supportive of the use of laboratory activities and field trips as teaching techniques.

III. School districts should look to NSTA for help in informing teachers about safety procedures and encouraging them to act responsibly in matters of safety and related liability.

IV. School districts should provide liability and tort insurance for the teachers.

V. Teachers, acting as agents of the school districts, should utilize laboratory investigations and field trips as instructional techniques.

VI. Teachers should learn safe procedures for laboratory activities and field trips and follow them as a matter of policy.

VII. Teachers should exercise reasonable judgment and supervision during laboratory activities and field trips.

VIII. Teachers should expect to be held liable if they fail to follow district policy and litigation ensues.

IX. School districts and teachers should share the responsibilities of establishing safety standards and seeing that they are adhered to.

—Adopted by the NSTA Board of Directors in July, 1985.

From the *NSTA Handbook, 1994-95*. Arlington, Va.: National Science Teachers Association, 1994, p. 242. Used with permission.

APPENDIX B

LEGAL CITATIONS

Excerpts from the *Education Code*, the *California Code of Regulations*, and the *Health and Safety Code* on topics that are of special significance to science educators are cited in this appendix, as indicated in the following list:

Education Code

School Eye Safety: Sections 32030, 32031, 32032, 32033
Alternatives to Dissection: Sections 32255.1, 32255.3, 32255.4, 32255.5
Earthquake Emergency Procedures: Sections 35295, 35296, 35297, 40041.5
Hazardous Materials Education: Sections 49340, 49341, 49401.5, 49411
Instruction in Personal and Public Health and Safety: Section 51202
Use of Animals in Public Instruction: Section 51540

California Code of Regulations, Title 8, General Industry Safety Orders

Ventilation Requirements for Laboratory-Type Hood Operations: Section 5154.1
Ventilation Requirements for Biological Safety Cabinets: Section 5154.2
Emergency Eyewash and Shower Equipment: Section 5162
Spill and Overflow Control: Section 5163
Storage of Hazardous Substances: Section 5164
Occupational Exposure to Hazardous Chemicals in Laboratories (Chemical Hygiene Plan): Section 5191
Bloodborne Pathogens: Section 5193
Hazard Communication; Material Safety Data Sheets: Section 5194

California Code of Regulations, Title 22

Specific Requirements for Milkrun Operations: Section 66263.42

Health and Safety Code

Humane Care of Animals: Sections 1650, 1651, 1660, 1662
Repeal of Requirement for Obtaining an Extremely Hazardous Waste Disposal Permit: Sections 25153, 25205.7(o)
Transporting Hazardous Waste: Sections 25163, 25163.1
Hazardous Materials Release Response Plans and Inventory: [Summary of] Section 25500 et seq.

Education Code

School Eye Safety

32030. Duties regarding eye protective devices

It shall be the duty of the governing board of every school district, and of every county superintendent of schools, and of every person, firm, or organization maintaining any private school, in this state, to equip schools with eye protective devices as defined in Section 32032, for the use of all students, teachers, and visitors when participating in the courses which are included in Section 32031. It shall be the duty of the superintendents, principals, teachers or instructors charged with the supervision of any class in which any such course is conducted, to require such eye protective devices to be worn by students, teachers, or instructors and visitors under the circumstances prescribed in Section 32031.

32031. Courses in which devices are to be used; substances and activities dangerous to eyes

The eye protective devices shall be worn in courses including, but not limited to, vocational or industrial arts shops or laboratories, and chemistry, physics or combined chemistry-physics laboratories, at any time at which the individual is engaged in, or observing, an activity or the use of hazardous substances likely to cause injury to the eyes.

Hazardous substances likely to cause physical injury to the eyes include materials which are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, radioactive, or which generate pressure through heat, decomposition or other means as defined in the California Hazardous Substances Labeling Act.[1]

Activity or the use of hazardous substances likely to cause injury to the eyes includes, but is not necessarily limited to, the following:

1. Working with hot molten metal.
2. Milling, sawing, turning, shaping, cutting, grinding, and stamping of any solid materials.
3. Heat treating, tempering, or kiln firing of any metal or other materials.
4. Gas or electric arc welding.

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[1] *Health and Safety Code* Section 28740 et seq.

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5. Repairing or servicing of any vehicles, or other machinery or equipment.
6. Working with hot liquids or solids or with chemicals which are flammable, toxic, corrosive to living tissues, irritating, strongly sensitizing, radioactive, or which generate pressure through heat, decomposition, or other means.

32032. Standards for devices

For purposes of this article the eye protective devices utilized shall be industrial quality eye protective devices which meet the standards of the American National Standards Institute for "Practice for Occupational and Educational Eye and Face Protection" (Z87.1–1968), and subsequent standards that are adopted by the American National Standards Institute for "Practice for Occupational and Educational Eye and Face Protection."

32033. Sale of devices at cost to pupils and teachers

The eye protective devices may be sold to the pupils and teachers or instructors at a price which shall not exceed the actual cost of the eye protective devices to the school or governing board.

Alternatives to Dissection

32255.1. Notice to teacher of objection; development of alternate education project; prohibition of discrimination against pupil; note from parent or guardian

(a) Except as otherwise provided in Section 32255.6, any pupil with a moral objection to dissecting or otherwise harming or destroying animals, or any parts thereof, shall notify his or her teacher regarding this objection, upon notification by the school of his or her rights pursuant to Section 32255.4.

(b) If the pupil chooses to refrain from participation in an education project involving the harmful or destructive use of animals, and if the teacher believes that an adequate alternative education project is possible, then the teacher may work with the pupil to develop and agree upon an alternate education project for the purpose of providing the pupil an alternate avenue for obtaining the knowledge, information, or experience required by the course of study in question.

(c) The alternative education project shall require a comparable time and effort investment by the pupil. It shall not, as a means of penalizing the pupil, be more arduous than the original education project.

(d) The pupil shall not be discriminated against based upon his or her decision to exercise his or her rights pursuant to this chapter.

(e) Pupils choosing an alternative educational project shall pass all examinations of the respective course of study in order to receive credit for that course of study. However, if tests require the harmful or destructive use of animals, a pupil may, similarly, seek alternative tests pursuant to this chapter.

(f) A pupil's objection to participating in an educational project pursuant to this section shall be substantiated by a note from his or her parent or guardian.

32255.3. Teacher's determination whether pupil may pursue alternative educational project; pursuit of grievance procedures

(a) A teacher's decision in determining if a pupil may pursue an alternative educational project or be excused from the project shall not be arbitrary or capricious.

(b) Nothing in this chapter shall prevent any pupil from pursuing the grievance procedures in existing law.

32255.4. Duty to inform pupils of rights

Each teacher teaching a course that utilizes live or dead animals or animal parts shall also inform the pupils [and their parents] of their rights pursuant to this chapter.

32255.5. Application of chapter to all levels of instruction

Notwithstanding any provision of law to the contrary, this chapter applies to all levels of instruction in all public schools operating programs from kindergarten through grades 1 to 12, inclusive.

Earthquake Emergency Procedures

35295. Legislative findings and declarations

The Legislature finds and declares the following:

(a) Because of the generally acknowledged fact that California will experience moderate to severe earthquakes in the foreseeable future, increased efforts to reduce earthquake hazards should be encouraged and supported.

(b) In order to minimize loss of life and disruption, it is necessary for all public or private elementary schools and high schools to develop school disaster plans and specifically an earthquake emergency procedure system so that students and staff will act instinctively and correctly when an earthquake disaster strikes.

(c) It is therefore the intent of the Legislature in enacting this article to authorize the establishment of earthquake emergency procedure systems in kindergarten and grades 1 through 12 in all the public or private schools in California.

35296. Establishment of systems

The governing board of each school district and the county superintendent of schools of each county shall establish an earthquake emergency procedure system in every public school building under its jurisdiction having occupant capacity of 50 or more pupils or more than one classroom. The governing board of each private school shall establish an earthquake emergency procedure system in every private school building under its jurisdiction having an occupant capacity of 50 or more pupils or more than one classroom. Governing boards and county superintendents may work with the Office of Emergency Services and the Seismic Safety Commission to develop and establish the earthquake emergency procedure systems.

35297. Components of system

The earthquake emergency procedure system shall include, but not be limited to, all of the following:

(a) A school building disaster plan, ready for implementation at any time, for maintaining the safety and care of students and staffs.

(b) A drop procedure. As used in this article, "drop procedure" means an activity whereby each student and staff member takes cover under a table or desk, dropping to his or her knees, with the head protected by the arms, and the back to the windows. A drop procedure practice shall be held at least once each school quarter in elementary schools and at least once a semester in secondary schools.

(c) Protective measures to be taken before, during, and following an earthquake.

(d) A program to ensure that the students and that both the certificated and classified staff are aware of, and properly trained in, the earthquake emergency procedure system.

40041.5. Mass care and welfare shelters

Notwithstanding Section 40043, the governing board of any school district shall grant the use of school buildings, grounds, and equipment to public agencies, including the American Red Cross, for mass care and welfare shelters during disasters or other emergencies affecting the public health and welfare. The governing board shall cooperate with these agencies in furnishing and maintaining such services as the governing board may deem necessary to meet the needs of the community.

Hazardous Materials Education

49340. This article shall be known and may be cited as the California Hazardous Materials Education Act of 1982.

Section 3 of Stats. 1982, c. 785, p. 3046, provides: "This act shall not be construed to impose any change in the duty of care required of school districts."

49341. The Legislature hereby finds and declares as follows:

(a) Because school science laboratories pose a potentially serious threat to the health and safety of school pupils and school personnel due to the use and storage of hazardous materials in these laboratories, educational efforts are needed to increase the awareness of persons dealing with these materials in these settings so that possible losses of life, injuries, loss of property, and social disruption which could result from the improper and unsafe use of hazardous materials will be minimized.

(b) Effective safety in school laboratories requires informed judgment, decision making, and operating procedures by those responsible for laboratory and related instruction. It is desirable that each high school and junior high, middle, or elementary school offering laboratory work have a trained member of the professional staff who is designated as the building laboratory consultant and who *is responsible for the review, updating, and carrying out of the school's adopted procedures for laboratory safety.* [emphasis added]

(c) Efforts by state and local agencies to implement training programs designed to provide qualified individuals with the necessary information, organizational skills, and materials to assist schools and teachers in the development of their laboratory safety policies and procedures are nonexistent or inadequate, and it is necessary that this situation be remedied. The state should assume leadership through the policy and guidance of the State Department of Education in the development, support, and implementation of a statewide training program.

(d) The Legislature requests that the Department of Education consider making this program a part of the department's energy and environmental education program which is conducted pursuant to Chapter 4 (commencing with Section 8700) of Part 6.

49401.5. Use and storage of hazardous materials; consultation services

(a) It is the intent of the Legislature in enacting this section to express its concern for the health and safety of school pupils and school personnel at schools where hazardous materials are stored on the school premises, and to encourage school districts to take steps to ensure hazardous materials are properly used and stored.

(b) The governing board of any school district may request consultation services from the California Occupational Safety and Health Consultation Service to ensure hazardous materials are being used and stored safely in school laboratories.

49411. Listing of chemical compounds used in school programs; guidelines for removal

(a) The State Department of Education, in cooperation with the Division of Occupational Safety and Health within the Department of Industrial Relations, shall formulate *a listing of chemical compounds used in school programs that includes the potential hazards and estimated shelf life of each compound.* [emphasis added]

(b) The Superintendent of Public Instruction, in cooperation with the Division of Occupational Safety and Health within the Department of Industrial Relations, shall develop guidelines for school districts for the regular removal and disposal of all chemicals whose estimated shelf life has elapsed.

(c) The county superintendent of schools may implement a system for disposing of chemicals from schools within the county or may permit school districts to arrange for the disposal of the chemicals.

[See Appendix C for reimbursable costs of implementing *Education Code* Section 49411. *Ed.*]

Instruction in Personal and Public Health and Safety

51202. Personal and public safety and accident prevention

The adopted course of study shall provide instruction at the appropriate elementary and secondary grade levels and subject areas in personal and public safety and accident prevention, including emergency first aid instruction, instruction in hemorrhage control, treatment for poisoning, resuscitation techniques, and cardiopulmonary resuscitation when appropriate equipment is available; fire prevention; the protection and conservation of resources, including the necessity for the protection of our environment; and health, including venereal disease and the effects of alcohol, narcotics, drugs, and tobacco upon the human body. The health instruction may include prenatal care for pregnant women and violence as a public health issue.

Use of Animals in Public Instruction

51540. Treatment of Animals

In the public elementary and high schools or in public elementary and high school school-sponsored activities and classes held elsewhere than on school premises, live vertebrate animals shall not, as part of a scientific experiment or any purpose whatever:

(a) Be experimentally medicated or drugged in a manner to cause painful reactions or induce painful or lethal pathological conditions.

(b) Be injured through any other treatments, including, but not limited to, anesthetization or electric shock.

Live animals on the premises of a public elementary or high school shall be housed and cared for in a humane and safe manner.

The provisions of this section are not intended to prohibit or constrain vocational instruction in the normal practices of animal husbandry.

California Code of Regulations, Title 8
General Industry Safety Orders

Ventilation Requirements for Laboratory-Type Hood Operations
5154.1.

. . . Laboratory-Type Hood. A device enclosed except for necessary exhaust purposes on three sides and top and bottom, designed to draw air inward by means of mechanical ventilation, operated with insertion of only the hands and arms of the user, and in which hazardous substances are used. These devices are also known as laboratory fume hoods.

(c) Ventilation Rates. Laboratory-type hood face velocities shall be sufficient to maintain an inward flow of air at all openings into the hood under operating conditions. The hood shall provide confinement of the possible hazards and protection of the employees for the work which is performed. The exhaust system shall provide an average face velocity of at least 100 linear feet per minute (lfm) with a minimum of 70 lfm at any point, except where more stringent special requirements are prescribed in other sections of the General Industry Safety Orders, such as Section 5209. The minimum velocity requirement excludes those measurements made within 1 inch of the perimeter of the work opening.

(d) Operation. Mechanical ventilation shall remain in operation at all times when hoods are in use and for a sufficient time thereafter to clear hoods of airborne hazardous substances. When mechanical ventilation is not in operation, hazardous substances in the hood shall be covered or capped off.

(e) Special Requirements.

(1) The face velocity required by subsection (c) should be obtainable with the movable sashes fully opened. Where the required velocity can be obtained by partly closing the sash, the sash and/or jamb shall be marked to show the maximum opening at which the hood face velocity will meet the requirements of subsection (c). Any hood failing to meet requirements of subsection (c) and this paragraph shall be considered deficient in airflow and shall be posted with placards, plainly visible, which prohibit use of hazardous substances within the hood.

(2) When flammable gases or liquids are used, or when combustible liquids are heated above their flashpoints, hoods that are not bypassed shall have permanent stops installed which will restrict closure of the sash so that sufficient airflow is maintained to prevent explosions. Concentrations in the duct shall not exceed 20% of the lower explosive limits.

(3) In addition to requirements in Section 5143(a)(5), a means shall be provided at the hood to continuously indicate that air is flowing into the exhaust system during operation. The ability of the hood to maintain an inward flow as required by (c) above shall be demonstrated using smoke tubes or other suitable qualitative methods upon initial installation; repairs or renovations of the facility, hood or ventilation system; or the addition of large equipment into the hood.

(4) Exhaust stacks shall be located in such a manner with respect to air intakes as to preclude the recirculation of laboratory-type hood emissions within a building. . . .

Ventilation Requirements for Biological Safety Cabinets

5154.2.

. . . (4) Biological safety cabinet. A ventilated cabinet which serves as a primary containment device for operations involving biohazard agents or biohazardous materials. Three classes of biological safety cabinets are described below:

Class I. The Class I biological safety cabinet is an open-fronted, negative pressure, ventilated cabinet. Exhaust air from the cabinet is filtered by a high-efficiency particulate air (HEPA) filter and discharged without internal recirculation. This cabinet may be used in three operational modes: with a full width open front, with an installed front closure panel not equipped with gloves, and with an installed front closure panel equipped with arm-length protective gloves.

Class II. The Class II vertical laminar flow biological safety cabinet is an open-fronted, ventilated cabinet. Exhaust air is filtered with a high-efficiency particulate air filter (HEPA). This cabinet provides HEPA-filtered downward air flow within the work space. . . .

Class III. The Class III biological safety cabinet is a totally enclosed, negative pressure, ventilated cabinet of gas-tight construction. . . .

Emergency Eyewash and Shower Equipment

5162.

(a) Plumbed or self-contained eyewash or eye/facewash equipment which meets the requirements of sections 5, 7, or 9 of ANSI Z358.1-1981, Emergency Eyewash and Shower Equipment, incorporated herein by this reference, shall be provided at all work areas where, during routine operations or foreseeable emergencies, the eyes of an employee may come into contact with a substance which can cause corrosion, severe irritation, or permanent tissue damage or which is toxic by absorption. Water hoses, sink faucets, or showers are not acceptable eyewash facilities. Personal eyewash units or drench hoses which meet the requirements of sections 6 or 8 of ANSI Z358.1-1981, incorporated herein by reference, may support plumbed or self-contained units but shall not be used in lieu of them.

(b) An emergency shower which meets the requirements of sections 4 or 9 of ANSI Z358.1-1981, incorporated herein by reference, shall be provided at all work areas where, during routine operations or foreseeable emergencies, areas of the body may come into contact with a substance which is corrosive or severely irritating to the skin or which is toxic by skin absorption.

(c) Location. Emergency eyewash facilities and deluge showers shall be in accessible locations that require no more than 10 seconds for the injured person to reach. If both an eyewash and shower are needed, they shall be located so that both can be used at the same time by one person. The area of the eyewash and shower equipment shall be maintained free of items which obstruct their use.

(d) Performance. Plumbed and self-contained eyewash and shower equipment shall supply potable water at the flow rate and time duration specified in ANSI Z358.1-1981. The control valve shall be designed so that the water flow remains on without requiring the use of the operator's hands, and so that the valve remains activated until intentionally shut off for all but hand-held drench hoses. Personal eyewash units shall deliver potable water or other eye-flushing solution approved by the consulting physician.

(e) Maintenance. Plumbed eyewash and shower equipment shall be activated at least monthly to flush the line and to verify proper operation. Other units shall be maintained in accordance with the manufacturer's instructions.

Spill and Overflow Control

5163.

(a) Where a corrosive substance is handled in an open container or drawn from a reservoir or pipe line, safe means shall be taken to neutralize or dispose of spills and overflows promptly. . . .

Storage of Hazardous Substances

5164.

(a) Substances which, when mixed, react violently, or evolve toxic vapors or gases, or which in combination become hazardous by reason of toxicity, oxidizing power, flammability, explosibility, or other properties, shall be separated from each other in storage by distance, by partitions, or otherwise, so as to preclude accidental contact between them. . . .

(b) Hazardous substances shall be stored in containers which are chemically inert to and appropriate for the type and quantity of the hazardous substance.

(c) Containers of hazardous substances shall not be stored in such locations or manner as to result in damage to the container. Containers shall not be stored where they are exposed to heat sufficient to rupture the containers or to cause leakage.

(d) Containers used to package a substance which gives off toxic, asphyxiant, suffocant, or anesthetic fumes in hazardous amounts (e.g., fuming sulfuric acid, hydrofluoric acid, compressed or liquefied toxic gases) shall not be stored in locations where it could be reasonably anticipated that employees would be exposed. . . .

Occupational Exposure to Hazardous Chemicals in Laboratories (Chemical Hygiene Plan)
5191.

(a) Scope and Application.

(1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

(2) Where this section applies, it shall supersede, for laboratories, the requirements of Title 8 of the *California Code of Regulations* Section 5190 and Article 110, Regulated Carcinogens of the General Industry Safety Orders, except as follows:

(A) The requirement to limit employee exposure to the specific exposure limit.

(B) When that particular regulation states otherwise, as in the case of Section 5209(c)(6).

(C) Prohibition or prevention of eye and skin contact where specified by any health regulation shall be observed.

(D) Where the action level (or in the absence of an action level, the exposure limit) is exceeded for a regulated substance with exposure monitoring and medical surveillance requirements.

(E) The "report of use" requirements of Article 110 (Section 5200 et seq.), Regulated Carcinogens regulations.

(F) Section 5217 shall apply to anatomy, histology and pathology laboratories. . . .

(b) Definitions.

Action level. A concentration designated in Title 8, *California Code of Regulations*, for a specific substance, calculated as an eight (8)-hour time weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance. . . .

Chemical Hygiene Officer. An employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. . . .

Chemical Hygiene Plan. A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that

(1) Are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular work place and

(2) Meet the requirements of subsection 5191(e). . . .

Designated area. An area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood. . . .

Laboratory use of hazardous chemicals. Handling or use of such chemicals in which all of the following conditions are met:

(1) Chemical manipulations are carried out on a "laboratory scale";

(2) Multiple chemical procedures or chemicals are used;

(3) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(4) "Protective laboratory practices and equipment" are available and in common use industry-wide to minimize the potential for employee exposure to hazardous chemicals. . . .

Physical hazard. A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive. . . .

Reproductive toxins. Chemicals which affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen. Any substance which meets one of the following criteria:

(1) It is regulated by Cal/OSHA as a carcinogen; or

(2) It is listed under the category "known to be carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) . . . ; or

(3) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) . . . ; or

(4) It is listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6–7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3;

(B) After repeated skin application of less than 300 mg/kg of body weight per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day. . . .

(c) Exposure limits. For laboratory uses of Cal/OSHA regulated substances, the employer shall ensure that laboratory employees' exposures to such substances do not exceed the exposure limits specified in Title 8, California Code of Regulations, Group 16, Section 5139 et seq., of the General Industry Safety Orders.

(d) Employee exposure determination.

(1) Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance exceed the action level (or in the absence of an action level, the exposure limit). . . .

(2) Periodic monitoring. If the initial monitoring prescribed by subsection 5191(d)(1) discloses employee exposure over the action level (or in the absence of an action level, the exposure limit), the employer shall immediately comply with the exposure monitoring provisions of the relevant regulation.

(3) Termination of monitoring. Monitoring may be terminated in accordance with the relevant regulation.

(4) Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

(e) Chemical hygiene plan.

(1) Where hazardous chemicals as defined by this regulation are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

(A) Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

(B) Capable of keeping exposures below the limits specified in subsection 5191(c).

(2) The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Chief.

(3) The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection:

(A) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

(B) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals, including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

(C) A requirement that fume hoods comply with Section 5154.1, that all protective equipment shall function properly and that specific measures shall be taken to ensure proper and adequate performance of such equipment;

(D) Provisions for employee information and training as prescribed in subsection 5191(f);

(E) The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

(F) Provisions for medical consultation and medical examinations in accordance with subsection 5191(g);

(G) Designation of personnel responsible for implementation of the Chemical Hygiene Plan, including the assignment of a Chemical Hygiene Officer and, if appropriate, establishment of a Chemical Hygiene Committee; and

(H) Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

1. Establishment of a designated area;
2. Use of containment devices such as fume hoods or glove boxes;
3. Procedures for safe removal of contaminated waste; and
4. Decontamination procedures.

(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

(f) Employee information and training.

(1) The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area. Information and training may relate to an entire class of hazardous substances to the extent appropriate.

(2) Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. . . .

(3) Information. Employees shall be informed of:

(A) The contents of this regulation and its appendices which shall be available to employees;

(B) The location and availability of the employer's Chemical Hygiene Plan;

(C) The exposure limits for Cal/OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable Cal/OSHA regulation;

(D) Signs and symptoms associated with exposure to hazardous chemicals used in the laboratory; and

(E) The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory, including, but not limited to, *Material Safety Data Sheets* received from the chemical supplier.

(4) Training.

(A) Employee training shall include:

1. Methods and observations that may be used to detect the presence or release of a hazardous chemical . . . ;
2. The physical and health hazards of chemicals in the work area; and
3. The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals. . . .

(B) The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

(g) Medical consultation and medical examinations.

(1) The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary . . . ;

(2) All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place;

(3) . . . The employer shall provide the following information to the physician:

(A) The identity of the hazardous chemical(s) to which the employee may have been exposed;

(B) A description of the conditions under which the exposure occurred, including quantitative exposure data, if available; and

(C) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

(4) Physician's written opinion.

(A) . . . The employer shall obtain a written opinion from the examining physician, which shall include the following:

1. Any recommendation for further medical follow-up;
2. The results of the medical examination and any associated tests; . . .
3. Any medical condition . . . which may place the employee at increased risk . . .; and
4. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

(B) The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

(h) Hazard identification.

(1) With respect to labels and material safety data sheets:

(A) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

(B) Employers shall maintain in the workplace any material safety data sheets that are received . . . and ensure that they are readily accessible to laboratory employees. . . .

(i) Use of respirators.

Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. . . .

(j) Recordkeeping.

(1) The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations, including tests or written opinions required by this regulation.

(2) The employer shall ensure that such records are kept, transferred, and made available in accordance with Section 3204.

(k) Dates.

(1) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than October 31, 1991. . . .

Bloodborne Pathogens
5193.

(a) This section applies to all occupational exposure to blood or other potentially infectious materials as defined by subsection (b) of this section.

(b) Definitions. For the purposes of this section, the following shall apply: . . .

"Blood" means human blood, human blood components, and products made from human blood.

"Bloodborne Pathogens" means pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV). . . .

"Contaminated" means the presence or the reasonably anticipated presence of blood or other potentially infectious materials on a surface or in or on an item.

"Contaminated Sharps" means any contaminated object that can penetrate the skin, including, but not limited to, needles, scalpels, broken glass, broken capillary tubes, and exposed ends of dental wires. . . .

"Decontamination" means the use of physical or chemical means to remove, inactivate, or destroy bloodborne pathogens on a surface or item to the point where they are no longer capable of transmitting infectious particles and the surface or item is rendered safe for handling, use, or disposal. Decontamination includes procedures regulated by *Health and Safety Code* Section 25090.

"Engineering Controls" means controls (e.g., sharps disposal containers, self-sheathing needles) that isolate or remove the bloodborne pathogens hazard from the workplace.

"Exposure Incident" means a specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials that results from the performance of an employee's duties.

"Handwashing Facilities" means a facility providing an adequate supply of running potable water, soap and single-use towels or hot-air drying machines.

"HBV" means hepatitis B virus.

"HIV" means human immunodeficiency virus. . . .

"Occupational Exposure" means reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties. . . .

"One-Hand Technique" means a procedure wherein the needle of a reusable syringe is capped in a sterile manner during use. The technique employed shall require the use of only the hand holding the syringe so that the free hand is not exposed to the uncapped needle.

"Other Potentially Infectious Materials" means:

(1) The following human body fluids: semen, vaginal secretions, cerespinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any other body fluid that is visibly contaminated with blood, such as saliva or vomitus, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids, such as emergency response;

(2) Any unfixed tissue or organ (other than intact skin) from a human (living or dead); and

(3) HIV-containing cell or tissue cultures, organ cultures, and HIV or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV. . . .

"Parenteral" means piercing mucous membranes or the skin barrier through such events as needlesticks, human bites, cuts, and abrasions. . . .

"Personal Protective Equipment" is specialized clothing or equipment worn or used by an employee for protection against a hazard. General work clothes (e.g., uniforms, pants, shirts or blouses) not intended to function as protection against a hazard are not considered to be personal protective equipment. . . .

"Regulated Waste" means liquid or semi-liquid blood or other potentially infectious materials in a liquid or semi-liquid state if compressed; items that are caked with dried blood or other potentially infectious materials and are capable of releasing these materials during handling; contaminated sharps; and pathological and microbiological wastes containing blood or other potentially infectious materials. Regulated Waste includes "medical waste" regulated by *Health and Safety Code* Chapter 6.1. . . .

"Source Individual" means any individual, living or dead, whose blood or other potentially infectious materials may be a source of occupational exposure to the employee. Examples include, but are not limited to, . . . trauma victims. . . .

"Sterilize" means the use of a physical or chemical procedure to destroy all microbial life, including highly resistant bacterial endospores. Sterilization includes procedures regulated by *Health and Safety Code* Section 25090.

"Universal Precautions" is an approach to infection control. According to the concept of Universal Precautions, all human blood and certain human body fluids are treated as if known to be infectious for HIV, HBV, and other bloodborne pathogens.

"Work Practice Controls" means controls that reduce the likelihood of exposure by altering the manner in which a task is performed (e.g., prohibiting recapping of needles by a two-handed technique).

(c) Exposure Control.

(1) Exposure Control Plan.

(A) Each employer having an employee(s) with occupational exposure as defined by subsection (b) of this section shall establish a written Exposure Control Plan which is designed to eliminate or minimize employee exposure . . . and which is also consistent with Section 3203.

(B) The Exposure Control Plan shall contain at least the following elements:

1. The exposure determination required by subsection (c)(2);

2. The schedule and method of implementation for each of the applicable subsections: (d) Methods of Compliance, (e) HIV and HBV Research Laboratories and Production Facilities, (f) Hepatitis B Vaccination and Post-exposure Evaluation and Follow-up, (g) Communication of Hazards to Employees, and (h) Recordkeeping, of this standard; and

3. The procedure for the evaluation of circumstances surrounding exposure incidents as required by subsection (f)(3)(A).

(C) Each employer shall ensure that a copy of the Exposure Control Plan is accessible to employees . . . in accordance with Section 3204(e).

(D) The Exposure Control Plan shall be reviewed and updated at least annually and whenever necessary to reflect new or modified tasks and procedures which affect occupational exposure, to reflect new or revised employee positions with occupational exposure, and to review the exposure incidents which occurred since the previous update.

(E) The Exposure Control Plan shall be made available to the Chief or NIOSH or their respective designee upon request for examination and copying.

(2) Exposure Determination.

(A) Each employer who has an employee(s) with occupational exposure shall prepare an exposure determination. This exposure determination shall contain the following:

1. A list of all job classifications in which all employees in those job classifications have occupational exposure;

2. A list of job classifications in which some employees have occupational exposure; and

3. A list of all tasks and procedures . . . in which occupational exposure occurs and that are performed by employees in job classifications listed in accordance with the provisions of subsection (c)(2)(A)2 of this standard.

(B) This exposure determination shall be made without regard to the use of personal protective equipment.

(d) Methods of Compliance.

(1) General. Universal precautions shall be observed to prevent contact with blood or other potentially infectious materials. Under circumstances in which differentiation between body fluid types is difficult or impossible, all body fluids shall be considered potentially infectious materials.

(2) Engineering and Work Practice Controls.

(A) Engineering and work practice controls shall be used to eliminate or minimize employee exposure. Where occupational exposure remains after institution of these controls, personal protective equipment shall also be used.

(B) Engineering controls shall be examined and maintained or replaced on a regular schedule to ensure their effectiveness.

(C) Employers shall provide handwashing facilities which are readily accessible to employees. . . .

(E) Employers shall ensure that employees wash their hands immediately or as soon as feasible after removal of gloves or other personal protective equipment.

(F) Employers shall ensure that employees wash hands and any other skin with soap and water, or flush mucous membranes with water immediately or as soon as feasible following contact of such body areas with blood or other potentially infectious materials.

(G) Contaminated needles and other contaminated sharps shall not be bent, recapped, or removed . . . except as noted in subsections (d)(2)(G)1 and (d)(2)(G)2 below. Shearing or breaking of contaminated needles is prohibited. . . .

(I) Eating, drinking, smoking, applying cosmetics or lip balm, and handling contact lenses are prohibited in work areas where there is a reasonable likelihood of occupational exposure.

(J) Food and drink shall not be kept in refrigerators, freezers, shelves, cabinets, or on countertops or benchtops where blood or other potentially infectious materials are present.

(K) All procedures involving blood or other potentially infectious materials shall be performed in such a manner as to minimize splashing, spraying, spattering, and generation of droplets of these substances.

(L) Mouth pipetting/suctioning of blood or other potentially infectious materials is prohibited.

(M) Specimens of blood or other potentially infectious materials shall be placed in a container which prevents leakage during collection, handling, processing, storage, transport, or shipping.

(1) The container for storage, transport, or shipping shall be labeled or color-coded according to subsection (g)(1)(A). . . .

(3) Personal Protective Equipment.

(A) Provision. When there is occupational exposure, the employer shall provide, at no cost to the employee, appropriate personal protective equipment such as, but not limited to, gloves, gowns, laboratory coats, face shields or masks and eye protection, and mouthpieces, resuscitation bags, pocket masks, or other ventilation devices. Personal protective equipment will be considered "appropriate" only if it does not permit blood or other potentially infectious materials to pass through to or reach the employee's work clothes, street clothes, undergarments, skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time which the protective equipment will be used. . . .

(B) Use. The employer shall ensure that the employee uses appropriate personal protective equipment unless the employer shows that the employee temporarily and briefly declined to use personal protective equipment when, under rare and extraordinary circumstances, it was the employee's professional judgment that in the specific instance its use would have prevented the delivery of health care or public safety services or would have posed an increased hazard to the safety of the worker or coworker. When the employee makes this judgment, the circumstances shall be investigated and documented in order to determine whether changes can be instituted to prevent such occurrences in the future. The employer shall encourage employees to report all such instances without fear of reprisal in accordance with Section 3203.

(C) Accessibility. The employer shall ensure that appropriate personal protective equipment in the appropriate sizes is readily accessible at the worksite or is issued to employees. Hypoallergenic gloves, glove liners, powderless gloves, or other similar alternatives shall be readily accessible to those employees who are allergic to the gloves normally provided.

(D) Cleaning, Laundering and Disposal. The employer shall clean, launder, and dispose of personal protective equipment required by subsections (d) and (e) of this standard, at no cost to the employee.

(E) Repair and Replacement. The employer shall repair or replace personal protective equipment as needed to maintain its effectiveness, at no cost to the employee.

(F) If a garment(s) is penetrated by blood or other potentially infectious materials, the garment(s) shall be removed immediately or as soon as feasible.

(G) All personal protective equipment shall be removed prior to leaving the work area.

(H) When personal protective equipment is removed it shall be placed in an appropriately designated area or container for storage, washing, decontamination, or disposal.

(I) Gloves shall be worn when it can be reasonably anticipated that the employee may have hand contact with blood, other potentially infectious materials, mucous membranes, and non-intact skin; when performing vascular access procedures except as specified in subsection (d)(3)(I)4; and when handling or touching contaminated items or surfaces. . . . These requirements are in addition to the provisions of Section 3384.

1. Disposable (single use) gloves, such as surgical or examination gloves, shall be replaced as soon as practical when contaminated or as soon as feasible if they are torn, punctured, or when their ability to function as a barrier is compromised.

2. Disposable (single use) gloves, shall not be washed or decontaminated for re-use.

3. Utility gloves may be decontaminated for re-use if the integrity of the glove is not compromised. However, they must be discarded if they are cracked, peeling, torn, punctured, or exhibit other signs of deterioration or when their ability to function as a barrier is compromised. . . .

(J) Masks, Eye Protection, and Face Shields. Masks in combination with eye protection devices, such as goggles or glasses with solid side shields, or chin-length face shields, shall be worn whenever splashes, spray, spatter, or droplets of blood or other potentially infectious materials may be generated and eye, nose, or mouth contamination can be reasonably anticipated. These requirements are in addition to the provisions of Section 3382. Where respiratory protection is used, the provisions of Section 5144 apply.

(K) Gowns, Aprons, and Other Protective Body Clothing. Appropriate protective clothing, such as, but not limited to, gowns, aprons, lab coats, clinic jackets, or similar outer garments, shall be worn in occupational exposure situations. The type and characteristics will depend upon the task and degree of exposure anticipated. These requirements are in addition to the provisions of Section 3383. . . .

(4) Housekeeping.

(A) General. Employers shall ensure that the worksite is maintained in a clean and sanitary condition. . . . The employer shall determine and implement an appropriate written schedule for cleaning and method of decontamination based upon the location within the facility, type of surface to be cleaned, type of soil present, and tasks or procedures being performed in the area.

(B) All equipment and environmental and working surfaces shall be cleaned and decontaminated after contact with blood or other potentially infectious materials. . . .

1. Contaminated work surfaces shall be decontaminated with an appropriate disinfectant after completion of procedures; immediately or as soon as feasible when surfaces are overtly contaminated or after any spill of blood or other potentially infectious materials; and at the end of the work shift if the surface may have become contaminated since the last cleaning.

2. Protective coverings, such as plastic wrap, aluminum foil, or imperviously-backed absorbent paper used to cover equipment and environmental surfaces, shall be removed and replaced as soon as feasible when they become overtly contaminated or at the end of the workshift if they may have become contaminated during the shift.

3. All bins, pails, cans, and similar receptacles intended for reuse which have a reasonable likelihood for becoming contaminated with blood or other potentially infectious materials shall be inspected and decontaminated on a regularly scheduled basis and cleaned and decontaminated immediately or as soon as feasible upon visible contamination.

4. Broken glassware which may be contaminated shall not be picked up directly with the hands. It shall be cleaned up using mechanical means, such as a brush and dust pan, tongs, or forceps.

5. Reusable sharps that are contaminated with blood or other potentially infectious materials shall not be stored or processed in a manner that requires employees to reach by hand into the containers where these sharps have been placed.

(C) Regulated Waste.

1. Contaminated Sharps Discarding and Containment.

a. Contaminated sharps shall be discarded immediately or as soon as feasible in containers that are:
   i. Closable;
   ii. Puncture resistant;
   iii. Leakproof on sides and bottom; and
   iv. Labeled in accordance with subsection (g)(1)(A) of this section.

b. During use, containers for contaminated sharps shall be:
   i. Easily accessible to personnel and located as close as is feasible to the immediate area where sharps are used or can be reasonably anticipated to be found;
   ii. Maintained upright throughout use; and
   iii. Replaced routinely and not be allowed to overfill. . . .

c. When moving containers of contaminated sharps from the area of use, the containers shall be:
   i. Closed immediately prior to removal or replacement to prevent spillage or protrusion of contents during handling, storage, transport, or shipping;
   ii. Placed in a secondary container if leakage is possible. The second container shall be:

A. Closable;

B. Constructed to contain all contents and prevent leakage during handling, storage, transport, or shipping; and

C. Labeled according to subsection (g)(1)(A) of this section.

d. Reusable containers shall not be opened, emptied, or cleaned manually or in any other manner which would expose employees to the risk of percutaneous injury.

2. Other Regulated Waste Containment.

a. Regulated waste shall be placed in containers which are:
   i. Closable;
   ii. Constructed to contain all contents and prevent leakage during handling, storage, transport, or shipping;
   iii. Labeled and color-coded in accordance with subsection (g)(1)(A) of this section; and
   iv. Closed prior to removal to prevent spillage or protrusion of contents during handling, storage, transport, or shipping.

b. If outside contamination of the regulated waste container occurs, it shall be placed in a second container. The second container shall be:
   i. Closable;
   ii. Constructed to contain all contents and prevent leakage during handling, storage, transport, or shipping;
   iii. Labeled and color-coded in accordance with subsection (g)(1)(A) of this section; and
   iv. Closed prior to removal to prevent spillage or protrusion of contents during handling, storage, transport, or shipping.

3. Handling, storage, treatment and disposal of all regulated waste shall be in accordance with *Health and Safety Code* Chapter 6.1 and other applicable regulations of the United States, the State, and political subdivisions of the state. . . .

(D) Laundry.

1. Contaminated laundry shall be handled as little as possible with a minimum of agitation.

a. Contaminated laundry shall be bagged or containerized at the location where it was used and shall not be sorted or rinsed in the location of use.

b. Contaminated laundry shall be placed and transported in bags or containers labeled or color-coded in accordance with subsection (g)(1)(A) of this standard. When a facility utilizes Universal Precautions in the handling of all soiled laundry, alternative labeling or color-coding is sufficient if it permits all employees to recognize the containers as requiring compliance with Universal Precautions.

c. Whenever contaminated laundry is wet and represents a reasonble likelihood of soak-through of or leakage from the bag or container, the laundry shall be placed and transported in bags or containers which prevent soak-through and/or leakage of fluids to the exterior.

2. The employer shall ensure that employees who have contact with contaminated laundry wear protective gloves and other appropriate personal protective equipment.

3. When a facility ships contaminated laundry off-site to a second facility which does not utilize Universal Precautions in the handling of all laundry, the facility generating the contaminated laundry must place such laundry in bags or containers which are labeled or color-coded in accordance with subsection (g)(1)(A). . . .

(f) Hepatitis B Vaccination and Post-exposure Evaluation and Follow-up.

(1) General

(A) The employer shall make available the hepatitis B vaccine and vaccination series to all employees who have occupational exposure, and post-exposure evaluation and follow-up to all employees who have had an exposure incident. . . .

Exception: Designated first aid providers who have occupational exposure are not required to be offered pre-exposure hepatitis B vaccine if the following conditions exist:

1. The primary job assignment of such designated first aid providers is not the rendering of first aid.

a. Any first aid rendered by such persons is rendered only as a collateral duty responding solely to injuries resulting from workplace incidents, generally at the location where the incident occurred. . . .

1.b.2. The employer's Exposure Control Plan, subsection (c)(1), shall specifically address the provision of hepatitis B vaccine to all unvaccinated first aid providers who have rendered assistance in any situation involving the presence of blood or other potentially infectious material (regardless of whether an actual exposure incident, as defined by subsection (b), occurred) and the provision of appropriate post-exposure evaluation, prophylaxis and follow-ups for those employees who experience an exposure incident as defined in subsection (b), . . . including:

a. Provisions for a reporting procedure that ensures that all first aid incidents involving the presence of blood or other potentially infectious material shall be reported to the employer before the end of the work shift during which the first aid incident occurred.

i. The report must include the names of all first aid providers who rendered assistance, regardless of whether personal protective equipment was used and must describe the first aid incident, including time and date.

A. The description must include a determination of whether or not, in addition to the presence of blood or other potentially infectious material, an exposure incident, as defined in subsection (b) occurred.

B. This determination is necessary in order to ensure that the proper post-exposure evaluation, prophylaxis and follow-up procedures required by subsection (f)(3) are made available immediately if there has been an exposure incident, as defined in subsection (b).

ii. The report shall be recorded on a list of such first aid incidents. It shall be readily available to all employees and shall be provided to the Chief upon request.

b. Provision for the bloodborne pathogens training program, required by subsection (g)(2), for designated first aiders to include the specifics of the reporting requirements of subsection (f)(3) and of this exception.

c. Provision for the full hepatitis B vaccination series to be made available as soon as possible, but in no event later than 24 hours, to all unvaccinated first aid providers who have rendered assistance in any situation involving the presence of blood or other potentially infectious material regardless of whether or not a specific exposure incident, as defined by subsection (b), has occurred.

3. The employer must implement a procedure to ensure that all of the provisions of subsection 2 of this exception are complied with if pre-exposure hepatitis B vaccine is not to be offered to employees meeting the conditions of subsection 1 of this exception.

(B) The employer shall ensure that all medical evaluations and procedures including the hepatitis B vaccine and vaccination series and post-exposure evaluation and follow-up, including prophylaxis, are:

1. Made available at no cost to the employee;

2. Made available to the employee at a reasonable time and place;

3. Performed by or under the supervision of a licensed physician or by or under the supervision of another licensed healthcare professional; and

4. Provided according to recommendations of the U.S. Public Health Service current at the time these evluations and procedures take place, except as specified by this subsection (f).

(C) The employer shall ensure that all laboratory tests are conducted by an accredited laboratory at no cost to the employee.

(2) Hepatitis B Vaccination.

(A) Hepatitis B vaccination shall be made available after the employee has received the training required in subsection (g)(2)(G)9 and within 10 working days of initial assignment to all employees who have occupational exposure unless the employee has previously received the complete hepatitis B vaccination series, antibody testing has revealed that the employee is immune, or the vaccine is contraindicated for medical reasons.

(B) The employer shall not make participation in a prescreening program a prerequisite for receiving hepatitis B vaccination.

(C) If the employee initially declines hepatitis B vaccination but at a later date while still covered under the standard decides to accept the vaccination, the employer shall make available hepatitis B vaccination at that time.

(D) The employer shall assure that employees who decline to accept hepatitis B vaccination offered by the employer sign the statement in Appendix A.

(E) If a routine booster dose(s) of hepatitis B vaccine is recommended by the U.S. Public Health Service at a future date, such booster dose(s) shall be made available in accordance with section (f)(1)(B).

(3) Post-exposure Evaluation and Follow-up.

Following a report of an exposure incident, the employer shall make immediately available to the exposed employee a confidential medical evaluation and follow-up, including at least the following elements:

(A) Documentation of the route(s) of exposure, and the circumstances under which the exposure incident occurred;

(B) Identification and documentation of the source individual, unless the employer can establish that identification is infeasible or prohibited by state or local law;

1. The source individual's blood shall be tested as soon as feasible and after consent is obtained in order to determine HBV and HIV infectivity. If consent is not obtained, the employer shall establish that legally required consent cannot be obtained. When the source individual's consent is not required by law, the source individual's blood, if available, shall be tested and the results documented.

2. When the source individual is already known to be infected with HBV or HIV, testing for the source individual's known HBV or HIV status need not be repeated.

3. Results of the source individual's testing shall be made available to the exposed employee, and the employee shall be informed of applicable laws and regulations concerning disclosure of the identity and infectious status of the source individual.

(C) Collection and testing of blood for HBV and HIV serological status;

1. The exposed employee's blood shall be collected as soon as feasible and tested after consent is obtained.

2. If the employee consents to baseline blood collection, but does not give consent at that time for HIV serologic testing, the sample shall be preserved for at least 90 days. If, within 90 days of the exposure incident, the employee elects to have the baseline sample tested, such testing shall be done as soon as feasible.

3. Additional collection and testing shall be made available as recommended by the U.S. Public Health Service

(D) Post-exposure prophylaxis, when medically indicated, as recommended by the U.S. Public Health Service;

(E) Counseling; and

(F) Evaluation of reported illnesses.

(4) Information Provided to the Healthcare Professional.

(A) The employer shall ensure that the healthcare professional responsible for the employee's hepatitis B vaccination is provided a copy of this regulation.

(B) The employer shall ensure that the healthcare professional evaluating an employee after an exposure incident is provided the following information:

1. A copy of this regulation;

2. A description of the exposed employee's duties as they relate to the exposure incident;

3. Documentation of the route(s) of exposure and circumstances under which exposure occurred, as required by subsection (f)(3)(A);

4. Results of the source individual's blood testing, if available; and

5. All medical records relevant to the appropriate treatment of the employee, including vaccination status, which are the employer's responsibility to maintain, as required by subsection (h)(1)(B)2.

(5) Healthcare Professional's Written Opinion.

The employer shall obtain and provide the employee with a copy of the evaluating healthcare professional's written opinion within 15 days of the completion of the evaluation.

(A) The healthcare professional's written opinion for hepatitis B vaccination shall be limited to whether hepatitis B vaccination is indicated for the employee, and if the employee has received such vaccination.

(B) The healthcare professional's written opinion for post-exposure evaluation and follow-up shall be limited to the following information:

1. That the employee has been informed of the results of the evaluation; and

2. That the employee has been told about any medical conditions resulting from exposure to blood or other potentially infectious materials which require further evaluation or treatment.

(C) All other findings or diagnoses shall remain confidential and shall not be included in the written report.

(6) Medical Recordkeeping.

Medical records required by this standard shall be maintained in accordance with subsection (h)(1) of this section.

(g) Communication of Hazards to Employees.

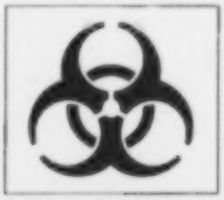
(1) Labels and Signs.

(A) Labels.

1. Warning labels shall be affixed to containers of regulated waste; refrigerators and freezers containing blood or other potentially infectious material; and other containers used to store, transport, or ship blood or other potentially infectious materials, except as provided in subsection (g)(1)(A)5, 6, and 7. . . .

Note: Other labeling provisions such as Health and Safety Code Sections 25080–25082 may be applicable.

2. Labels required by this section shall include either the following legend as required by Section 6004:



BIOHAZARD

or, in the case of regulated waste, the legend:

BIOHAZARDOUS WASTE

as described in *Health and Safety Code* Sections 25080–25082.

3. These labels shall be fluorescent orange or orange-red or predominantly so with lettering and symbols in a contrasting color.

4. Labels required by subsection (g)(1)(A) shall either be an integral part of the container or shall be affixed as close as feasible to the container by string, wire, adhesive, or other method that prevents their loss or unintentional removal.

5. Red bags or red containers may be substituted for labels except for sharp containers or regulated waste red bags. . . . Bags used to contain regulated waste shall be color-coded red and shall be labeled in accordance with subsection (g)(1)(A)2. Labels on red bags or red containers do not need to be color-coded in accordance with subsection (g)(1)(A)3.

6. Containers of blood, blood components, or blood products that are labeled as to their contents and have been released for transfusion or other clinical use are exempted from the labeling requirements of subsection (g).

7. Individual containers of blood or other potentially infectious materials that are placed in a labeled container during storage, transport, shipment, or disposal are exempted from the labeling requirement.

8. Labels required for contaminated equipment shall be in accordance with this subsection and shall also state which portions of the equipment remain contaminated.

9. Regulated waste that has been decontaminated need not be labeled or color-coded. . . .

(2) Information and Training.

(A) Employers shall ensure that all employees with occupational exposure participate in a training program which must be provided at no cost to the employee and during working hours.

(B) Training shall be provided as follows:

1. At the time of initial assignment to tasks where occupational exposure may take place;

2. At least annually thereafter. . . .

(C) For employees who have received training on bloodborne pathogens in the year preceding the effective date of the standard, only training with respect to the provisions of the standard which were not included need be provided.

(D) Annual training for all employees shall be provided within one year of their previous training.

(E) Employers shall provide additional training when changes such as modification of tasks or procedures or institution of new tasks or procedures affect the employee's occupational exposure. The additional training may be limited to addressing the new exposures created.

(F) Material appropriate in content and vocabulary to educational level, literacy, and language of employees shall be used.

(G) The training program shall contain at a minimum the following elements:

1. An accessible copy of the regulatory text of this standard and an explanation of its contents;

2. A general explanation of the epidemiology and symptoms of bloodborne diseases;

3. An explanation of the modes of transmission of bloodborne pathogens;

4. An explanation of the exposure control plan and the means by which the employee can obtain a copy of the written plan;

5. An explanation of the appropriate methods for recognizing tasks and other activities that may involve exposure to blood and other potentially infectious materials;

6. An explanation of the use and limitations of methods that will prevent or reduce exposure including appropriate

engineering controls, work practices, and personal protective equipment;

7. Information on the types, proper use, location, removal, handling decontamination and disposal of personal protective equipment;

8. An explanation of the basis for selection of personal protective equipment;

9. Information on the hepatitis B vaccine, including information on its efficacy, safety, method of administration, the benefits of being vaccinated, and that the vaccine and vaccination will be offered free of charge;

10. Information on appropriate actions to take and persons to contact in an emergency involving blood or other potentially infectious materials;

11. An explanation of the procedure to follow if an exposure incident occurs, including the method of reporting the incident and the medical follow-up that will be made available;

12. Information on the post-exposure evaluation and follow-up that the employer is required to provide for the employee following an exposure incident;

13. An explanation of the signs and labels and/or color coding required by subsection (g)(1); and

14. An opportunity for interactive questions and answers with the person conducting the training session. . . .

(H) The person conducting the training shall be knowledgeable in the subject matter covered by the elements contained in the training program as it relates to the workplace that the training will address.

(h) Recordkeeping.

(1) Medical Records.

(A) The employer shall establish and maintain an accurate record for each employee with occupational exposure, in accordance with Section 3204. . . .

(B) This record shall include:

1. The name and social security number of the employee;

2. A copy of the employee's hepatitis B vaccination status, including the dates of all the hepatitis B vaccinations and any medical records relative to the employee's ability to receive vaccination as required by subsection (f)(2);

3. A copy of all results of examinations, medical testing, and follow-up procedures as required by subsection (f)(3);

4. The employer's copy of the healthcare professional's written opinion as required by subsection (f)(5); and

5. A copy of the information provided to the healthcare professional as required by subsections (f)(4)(B)2, 3, and 4.

(C) Confidentiality. The employer shall ensure that employee medical records required by subsection (h)(1) are:

1. Kept confidential; and

2. Not disclosed or reported without the employee's express written consent to any person within or outside the workplace except as required by this section or as may be required by law.

(D) The employer shall maintain the records required by subsection (h)(1) for at least the duration of employment plus 30 years in accordance with Section 3204.

(2) Training Records.

(A) Training records shall include the following information:

1. The dates of the training sessions;

2. The contents or a summary of the training sessions;

3. The names and qualifications of persons conducting the training; and

4. The names and job titles of all persons attending the training sessions.

(B) Training records shall be maintained for 3 years from the date on which the training occurred.

(3) Availability.

(A) The employer shall ensure that all records required to be maintained by this section shall be made available upon request to the Chief and NIOSH for examination and copying.

(B) Employee training records required by this subsection shall be provided upon request for examination and copying to employees to employee representatives, to the Chief, and to NIOSH.

(C) Employee medical records required by this subsection shall be provided upon request for examination and copying to the subject employee, to anyone having written consent of the subject employee, to the Chief, and to NIOSH in accordance with Section 3204.

(4) Transfer of Records.

(A) The employer shall comply with the requirements involving transfer of records set forth in Section 3204.

(B) If the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, the employer shall notify NIOSH at least three months prior to their disposal and transmit them to the NIOSH, if required by the NIOSH to do so, within that three-month period.

(i) Dates.

(1) The Exposure Control Plan required by subsection (c)(1) of this section shall be completed within 60 days of the effective date of this standard.

(2) Subsection (g)(2) Information and Training and (h) Recordkeeping shall take effect within 90 days of the effective date of this standard.

(3) Subsections (d)(2) Engineering and Work Practice Controls, (d)(3) Personal Protective Equipment, (d)(4) Housekeeping, (e) HIV and HBV Research Laboratories and Production Facilities, (f) Hepatitis B Vaccination and Post-Exposure Evaluation and Follow-up, and (g)(1) Labels and Signs shall take effect 120 days after the effective date of this standard.

(j) Appendix.

Appendix A to this section is incorporated as a part of this section and the provision is mandatory.

Appendix A - Hepatitis B Vaccine Declination (MANDATORY)

The employer shall assure that employees who decline to accept hepatitis B vaccination offered by the employer sign the following statement as required by subsection (f)(2)(D):

I understand that due to my occupational exposure to blood or other potentially infectious materials I may be at risk of acquiring hepatitis B virus (HBV) infection. I have been given the opportunity to be vaccinated with hepatitis B vaccine, at no charge to myself. However, I decline hepatitis B vaccination at this time. I understand that by declining this vaccine, I continue to be at risk of acquiring hepatitis B, a serious disease. If in the future I continue to have occupational exposure to blood or other potentially infectious materials and I want to be vaccinated with hepatitis B vaccine, I can receive the vaccination series at no charge to me. . . .

Hazard Communication; Material Safety Data Sheets 5194.

[See Chapter 5, Section E, for information about meeting the requirements of this section. *Ed.*]

(b) Scope and Application

(1) This section requires . . . all employers to provide information to their employees about the hazardous substances to which they may be exposed, by means of a hazard communication program, labels and other forms of warning, material safety data sheets, and information and training. . . .

(2) This section applies to any hazardous substance which is known to be present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a reasonably foreseeable emergency resulting from workplace operations.

(3) This section applies to laboratories that primarily provide quality control analyses for manufacturing processes or that produce hazardous substances for commercial purposes, and to all other laboratories *except those under the direct supervision and regular observation of an individual who has knowledge of the physical hazards, health hazards, and emergency procedures associated with the use of the particular hazardous substances involved, and who conveys this knowledge to employees in terms of safe work practices.* [emphasis added] Such excepted laboratories must also ensure that labels of incoming containers of hazardous substances are not removed or defaced . . . and must maintain any material safety data sheets that are received with incoming shipments of hazardous substances and ensure that they are readily available to laboratory employees. . . .

(d) Hazard Determination.

(1) Manufacturers and importers shall evaluate substances produced in their workplaces or imported by them to determine if they are hazardous. *Employers are not required to evaluate substances unless they choose not to rely on the evaluation performed by the manufacturer or importer for the substance to satisfy this requirement. . . .* [emphasis added]

(e) Written Hazard Communication Program.

(1) Employers shall develop, implement, and maintain at the workplace a written hazard communication program for their employees which at least describes how the criteria specified in sections 5194 (f), (g), and (h) for labels and other forms of warning, material safety data sheets, and employee information and training will be met, and which also includes the following:

(A) A list of the hazardous substances known to be present using an identity that is referenced on the appropriate material safety data sheet (the list may be compiled for the workplace as a whole or for individual work areas);

(B) The methods the employer will use to inform employees of the hazards of nonroutine tasks (for example, the cleaning of reactor vessels) and the hazards associated with substances contained in unlabeled pipes in their work areas.

(2) . . . the written hazard communication program shall include the methods employers will use to inform any employers sharing the same work area of the hazardous substances to which their employees may be exposed while performing their work, and any suggestions for appropriate protective measures. . . .

(3) The employer shall make the written hazard communication program available, upon request, to employees, their designated representatives, the Chief, and NIOSH, in accordance with the requirements of Section 3204(e).

(f) Labels and Other Forms of Warning.

Note to (f): The requirements at sections 5225–5230 for labeling of all containers containing highly toxic, corrosive, flammable, oxidizing or pyrophoric substances apply to all employers, and apply regardless of any exception or allowance in Section 5194(f).

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(1) The manufacturer, importer, or distributor shall ensure that each container of hazardous substances leaving the workplace is labeled, tagged, or marked with the following information:

(A) Identity of the hazardous substance(s);

(B) Appropriate hazard warnings; and

(C) Name and address of the manufacturer, importer, or other responsible party. . . .

(2) Manufacturers, importers, or distributors shall ensure that each container of hazardous substances leaving the workplace is labeled, tagged, or marked in accordance with this section in a manner which does not conflict with the requirements of the Hazardous Materials Transportation Act (18 U.S.C. 1801 et seq.) and regulations issued under that Act by the Department of Transportation.

(3) If the hazardous substance is regulated by these orders in a substance-specific health standard, the manufacturer, importer, distributor, or employer shall ensure that the labels or other forms of warning used are in accordance with the requirements of that standard.

(4) Except as provided in sections 5194(f)(5) and (f)(6) the employer shall ensure that each container of hazardous substances in the workplace is labeled, tagged, or marked with the following information:

(A) Identity of the hazardous substance(s) contained therein; and

(B) Appropriate hazard warnings.

(5) The employer may use signs, placards, process sheets, batch tickets, operating procedures, or other such written materials in lieu of affixing labels to individual stationary process containers, as long as the alternative method identifies the containers to which it is applicable and conveys the information required by Section 5194(f)(4) to be on a label. The written materials shall be readily accessible to the employees in their work area throughout each work shift. . . .

(6) The employer is not required to label portable containers into which hazardous substances are transferred from labeled containers, and which are intended only for the immediate use of the employee who performs the transfer. . . .

(7) The employer shall not remove or intentionally deface existing labels on incoming containers of hazardous substances, unless the container is immediately marked with the required information.

(8) The employer shall ensure that labels or other forms of warning are legible, in English, and prominently displayed on the container, or readily available in the work area throughout each work shift. Employers having employees who speak other languages may add the information in their language to the material presented, as long as the information is presented in English as well.

(9) The manufacturer, importer, distributor, or employer need not affix new labels to comply with this section if existing labels already convey the required information.

(g) Material Safety Data Sheets.

(1) . . . Employers shall have a material safety data sheet for each hazardous substance which they use.

Note to (g)(1): Employers should also refer to Section 3204 concerning information to be retained after a particular substance is no longer in use.

(2) Each material safety data sheet shall be in English and shall contain at least the following information:

(A) The identity used on the label, and, except as provided for in Section 5194(i) on trade secrets:

1. If the hazardous substance is a single substance, its chemical and common name(s) and CAS number(s);

2. If the hazardous substance is a mixture which has been tested as a whole to determine its hazards, the chemical, common name(s), and CAS number(s) of the ingredients which contribute to these known hazards, and the common name(s) of the mixture itself; or,

3. If the hazardous substance is a mixture which has not been tested as a whole:

a. The chemical and common name(s), and CAS number(s) of all ingredients which have been determined to be health hazards, and which comprise 1% or greater of the composition, except that substances identified as carcinogens under subsection 5194(d)(4) shall be listed if the concentrations are 0.1% or greater;

b. The chemical and common name(s), and CAS number(s) of all ingredients which comprise less than 1% (0.1% for carcinogens) of the mixture, if there is evidence that the ingredient(s) could be released from the mixture in concentrations which would exceed an established OSHA permissible exposure limit or ACGIH Threshold Limit Value, or could present a health hazard to employees; and,

c. The chemical, common name(s) and CAS number(s) of all ingredients which have been determined to present a physical hazard when present in the mixture;

(B) Physical and chemical properties of the hazardous substance (such as vapor pressure, flashpoint);

(C) The physical hazards of the hazardous substance, including the potential for fire, explosion, and reactivity;

(D) The health hazards of the hazardous substance, including signs and symptoms of exposure, and any medical conditions which are generally recognized as being aggravated by exposure to the substance;

(E) The potential route(s) of entry;

(F) The OSHA permissible exposure limit, ACGIH Threshold Limit Value, and any other exposure limit used or recommended by the manufacturer, importer, or employer preparing the material safety data sheet, where available;

(G) Whether the hazardous substance is listed in the National Toxicology Program (NTP) *Sixth Annual Report on Carcinogens* or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) *Monographs*, Vols. 1–53 and Supplements 1–8, or by OSHA;

(H) Any generally applicable precautions for safe handling and use which are known to the manufacturer, importer, or employer preparing the material safety data sheet, including the appropriate hygienic practices, protective measures during repair and maintenance of contaminated equipment, and procedures for cleanup of spills and leaks;

(I) Any generally applicable control measures which are known to the manufacturer, importer, or employer preparing the material safety data sheet, such as appropriate engineering controls, work practices, or personal protective equipment;

(J) Emergency and first-aid procedures;

(K) The date of preparation of the material safety data sheet or the last change to it;

(L) The name, address and telephone number of the manufacturer, importer, employer, or other responsible party preparing or distributing the material safety data sheet, who can provide additional information on the hazardous substance and appropriate emergency procedures, if necessary; and,

(M) A description in lay terms, if not otherwise provided, on either a separate sheet or with the body of the information specified in this section, of the specific potential health risks posed by the hazardous substance intended to alert any person reading the information. . . .

(8) The employer shall maintain copies of the required material safety data sheets for each hazardous substance in the workplace, and shall ensure that they are readily accessible during each work shift to employees when they are in their work area(s). . . .

(10) Material safety data sheets may be kept in any form, including operating procedures, and may be designed to cover groups of hazardous substances in a work area where it may be more appropriate to address the hazards of a process rather than individual hazardous substances. . . .

(11) Material safety data sheets shall also be made readily available, upon request, to designated representatives, and to the Chief, in accordance with the requirements of Section 3204(e). NIOSH and the employee's physician shall also be given access to material safety data sheets in the same manner.

(12) If the material safety data sheet, or any item of information required by Section 5194(g)(2), is not provided by the manufacturer or importer, the employer shall:

(A) Within 7 working days of noting this missing information, either from a request or in attempting to comply with Section 5194(1), make written inquiry to the manufacturer or importer of a hazardous substance responsible for the material safety data sheet, asking that the complete material safety data sheet be sent to the employer. If the employer has made written inquiry in the preceding 12 months as to whether the substance or product is subject to the requirements of the Act or the employer has made written inquiry within the last 6 months requesting new, revised or later information on the material safety data sheet for the hazardous substance, the employer need not make additional written inquiry.

(B) Notify the requestor in writing of the date that the inquiry was made, to whom it was made, and the response, if any, received. Providing the requestor with a copy of the inquiry sent to the manufacturer, producer or seller and a copy of the response will satisfy this requirement.

(C) Notify the requestor of the availability of the material safety data sheet within 15 days of the receipt of the material safety data sheet from the manufacturer, producer or seller or provide a copy of the material safety data sheet to the requestor within 15 days of the receipt of the material safety data sheet from the manufacturer, producer or seller.

(D) Send the Director [of Industrial Relations] a copy of the written inquiry if a response has not been received within 25 working days.

(13) The preparer of a material safety data sheet shall provide the Director with a copy of the material safety data sheet. Where a trade secret claim is made, the preparer shall submit the information specified in Section 5194(i)(15).

(h) Employee Information and Training.

(1) Employers shall provide employees with information and training on hazardous substances in their work area at the time of their initial assignment, and whenever a new hazard is introduced into their work area. Information and training may relate to general classes of hazardous substances to the extent appropriate and related to reasonably foreseeable exposures of the job.

(2) Information and training shall consist of at least the following topics:

(A) Employees shall be informed of the requirements of this section.

(B) Employees shall be informed of any operations in their work area where hazardous substances are present.

(C) Employees shall be informed of the location and availability of the written hazard communication program. . . .

(D) Employees shall be trained in the methods and observations that may be used to detect the presence or release of a hazardous substance in the work area (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous substances when being released, etc.).

(E) Employees shall be trained in the physical and health hazards of the substances in the work area, and the measures they can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous substances, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

(F) Employees shall be trained in the details of the hazard communication program developed by the employer, including an explanation of the labeling system and the material safety data sheet, and how employees can obtain and use the appropriate hazard information.

(G) Employers shall inform employees of the right:

1. To personally receive information regarding hazardous substances to which they may be exposed, according to the provisions of this section;

2. For their physician or collective bargaining agent to receive information regarding hazardous substances to which the employee may be exposed according to provisions of this section;

3. Against discharge or other discrimination due to the employee's exercise of the rights afforded pursuant to the provisions of the Hazardous Substances Information and Training Act.

(3) Whenever the employer receives a new or revised material safety data sheet, such information shall be provided to employees on a timely basis not to exceed 30 days after receipt, if the new information indicates significantly increased risks to, or measures necessary to protect, employee health as compared to those stated on a material safety data sheet previously provided.

(i) Trade Secrets.

[*Note:* The text is not included here. This section provides for the withholding of the specific chemical identity of trade secrets on material safety data sheets as long as information concerning the properties and effects of the hazardous substance is disclosed. If a physician or nurse determines that a medical emergency exists and the chemical identity of the substance is necessary for treatment, the chemical identity must be disclosed immediately. A confidentiality agreement may be a provision of the disclosure. *Ed.*]

Appendixes A through D to Section 5194 are not reprinted here. The titles of those appendixes are as follows:

Appendix A : Health Hazard Definitions (Mandatory)

Appendix B: Hazard Determination (Mandatory) [outlines the principles and procedures of hazard assessment]

Appendix C: Information Sources (Advisory) [gives a list of data sources that may be consulted to evaluate the hazards of substances]

Appendix D: Definition of "Trade Secret" (Mandatory)

California Code of Regulations, Title 22

Specific Requirements for Milkrun Operations 66263.42.

(a) The following may be transported in accordance with the requirements of this section:

(1) Spent photographic solutions;

(2) Ethylene glycol automotive antifreeze;

(3) Sludge containing sodium hydroxide and heavy metals;

(4) Dry cleaning solvents (including perchloroethylene);

(5) Asbestos;

(6) Inks from the printing industry;

(7) Chemicals and laboratory packs collected from school districts;

(8) Automotive parts cleaning solvents.

(b) This section applies only to hazardous wastes that are either:

(1) Subject to reclamation agreements with generators of greater than 100 kilograms per month but less than 1,000 kilograms per month pursuant to the requirements of Title 40 of the *Code of Federal Regulations*, sections 262.20(e) and 263.20(h), as of July 1, 1988; or

(2) Collected from generators who meet the requirements of Title 40 of the *Code of Federal Regulations*, sections 261.5(a) and 251.5(9), as of July 1, 1988; or

(3) Collected from generators of non-RCRA hazardous wastes totaling less than 100 kilograms per calendar month.

(c) A transporter operating in accordance with this section may transport from any number of generators.

(d) A Uniform Hazardous Waste Manifest (Form DHS 8022A [now DTSC 8022A]) completed pursuant to the following instructions prior to the first collection shall be in the driver's possession when transporting the above-mentioned hazardous waste. A new manifest shall be completed whenever the driver changes, transport vehicle changes, a new day begins, or upon the last delivery of the hazardous waste to the designated facility. The modified manifesting procedures are as follows:

(1) The transporter shall be responsible for completing both the generator and transporter section of the manifest.

(2) The transporter's name and EPA Identification Number shall be entered in both the generator information and transporter information spaces of the manifest.

(3) The transporter shall attach to the front of the manifest legible copies of the receipts or shipping papers for the waste collected. The receipts or shipping papers shall be used to determine the total quantity of waste in the vehicle. After the waste is delivered, the receipts or shipping papers shall be affixed to the transporter's copy of the manifest. The manifest and receipts or shipping papers shall be kept for three years. The receipts or shipping papers shall contain the following information:

(A) Each generator's name, address and EPA Identification Number;

(B) The name of each generator's contact person, telephone number and signature of the generator's representative;

(C) The transporter's name, address and EPA Identification Number;

(D) The proper shipping name, hazard class and United Nations/North America (UN/NA) identification number, as applicable;

(E) The quantity of waste collected from each generator;

(F) The date the waste was accepted by the transporter;

(G) The name, address and EPA Identification Number, if applicable, of the authorized facility to which the hazardous waste will be transported;

(H) In the case of school chemical collections, the drum number which contains the accepted waste;

(I) The manifest document number.

(4) At the completion of each day, the transporter shall enter the total volume or weight of the waste on the manifest. The total volume or weight shall be the cumulative amount of waste collected from the generators listed on the attached receipts or shipping papers.

(5) The transporter shall sign and date both generator and transporter sections of the manifest and shall submit the generator copy of the manifest to the Department within 30 days of the acceptance of the waste by the transporter.

(6) All copies of the manifest shall be submitted to the treatment, storage or disposal facility (TSDF) operator upon delivery of the waste.

(7) After completion of the TSDF portion, the original manifest shall be submitted to the Department of Toxic Substances Control within 30 days. The copy of the manifest (Labeled: "Yellow: TSDF SENDS THIS COPY TO GENERATOR WITHIN 30 DAYS") which is otherwise returned to the generator by the TSDF operator shall instead be returned to the transporter.

(e) The transporter shall leave a receipt or shipping paper with the generator for the waste collected. Generators shall keep these receipts or shipping papers for three years.

(f) The period of retention referred to in this section is extended automatically during the course of any unresolved enforcement action regarding the regulated activity or as requested by the Department.

(g) The hazardous waste shall be delivered to a permitted hazardous waste facility or to a facility which has been granted interim status, or to a facility which has been otherwise authorized to receive hazardous wastes pursuant to Chapter 6.5 of Division 20 of the *Health and Safety Code* and implementing regulations.

(h) Handling practices and storage time of the hazardous wastes shall be allowed the same exemptions described in Section 66263.18 of this chapter, when applied to handling and storage at transfer facilities.

Note: Authority cited: Sections 208, 25143, 25150, and 25161, *Health and Safety Code*. Reference: Sections 25117.9, 25143, 25160, 25168, 25169, and 25169.1, *Health and Safety Code*.

Ordering Information
(for manifests)

Note: Manifests are not necessary when (1) a noncommercial waste producer transports small quantities of waste (*Health and Safety Code* Section 25163[c]); and (2) the waste is disposed of by "milkrun," in which case the *transporter provides the manifest* (*California Code of Regulations, Title 22*, Section 66263.42).

When necessary, order a packet of Uniform Hazardous Waste Manifests from:

Department of General Services—Publications
P.O. Box 1015
North Highlands, CA 95660

Send a check in the amount of $15 and include a street address for United Parcel Service (UPS) delivery.

State of California—Environmental Protection Agency
Form Approved OMB No. 2050–0039 (Expires 9-30-94)
Please print or type. *Form designed for use on elite (12-pitch) typewriter.*

See Instructions on back of page 6.

Department of Toxic Substances Control
Sacramento, California

95103157

IN CASE OF EMERGENCY OR SPILL, CALL THE NATIONAL RESPONSE CENTER 1-800-424-8802; WITHIN CALIFORNIA, CALL 1-800-852-7550

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No.
Manifest Document No.
2. Page 1 of
Information in the shaded areas is not required by Federal law.

G E N E R A T O R

3. Generator's Name and Mailing Address
A. State Manifest Document Number 9510315
B. State Generator's ID [illegible]
4. Generator's Phone ( )
5. Transporter 1 Company Name
6. US EPA ID Number
C. [illegible]
D. [illegible]
7. Transporter 2 Company Name
8. US EPA ID Number
E. [illegible]
F. [illegible]
9. Designated Facility Name and Site Address
10. US EPA ID Number
G. State Facility's ID [illegible]
H. Facility's Phone [illegible]

11. US DOT Description (including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers No.	12. Containers Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste Number
a.					State EPA/Other
b.					State EPA/Other
c.					State EPA/Other
d.					State EPA/Other

J. [illegible]
K. Handling Codes for Wastes Listed Above [illegible]

SAMPLE

15. Special Handling Instructions and Additional Information

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name	Signature	Month	Day	Year

T R A N S P O R T E R

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Month	Day	Year

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Month	Day	Year

F A C I L I T Y

19. Discrepancy Indication Space

20. Facility Owner or Operator Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name	Signature	Month	Day	Year

DO NOT WRITE BELOW THIS LINE.

DTSC 8022A (9/93)
EPA 8700—22

White: TSDF SENDS THIS COPY TO DTSC WITHIN 30 DAYS.
To: P.O. Box 3000, Sacramento, CA 95812

WHEN COMPLETING THIS FORM REFER TO 40 CFR, PART 262, APPENDIX AND CCR, TITLE 22, DIVISION 4.5, CHAPTER 12, APPENDIX

INSTRUCTIONS FOR GENERATORS

Item 1. Generator's U.S. EPA ID Number—Manifest Document Number: Enter the generator's U.S. EPA 12-digit identification number. The five-digit space to the right can be used for your own internal tracking system. A number there is not required.

Item 2. Page 1 of ____: Enter the total number of pages used to complete the Manifest plus the number of Continuation Sheets, if any.

Item 3. Generator's Name and Mailing Address: Enter the name and mailing address of the generator. The address should be the location that will manage the returned Manifest forms.

Item 4. Generator's Phone Number: Enter a telephone number where an authorized agent of the generator may be reached in the event of an emergency.

Item 5. Transporter 1 Company Name: Enter the company name of the first transporter who will transport the waste.

Item 6. U.S. EPA ID Number: Enter the U.S. EPA 12-digit identification number of the first transporter identified in Item 5.

Item 7. Transporter 2 Company Name. If applicable, enter the company name of the second transporter who will transport the waste. If more than two transporters are used to transport the waste, use a Continuation Sheet(s) and list the transporters in the order they will be transporting the waste.

Item 8. U.S. EPA ID Number: If applicable, enter the U.S. EPA 12-digit identification number of the second transporter identified in Item 7.

Item 9. Designated Facility Name and Site Address: Enter the company name and site address of the facility designated to receive the waste listed on this Manifest. The address must be the site address which may differ from the company mailing address.

Item 10. U.S. EPA ID Number: Enter the U.S. EPA 12-digit identification number of the designated facility identified in Item 9.

Item 11. U.S. DOT Description: Enter the U.S. DOT Proper Shipping Name, Hazard Class, and ID Number (UN/NA) for each waste as identified in 49 CFR 171 through 177. For non-RCRA hazardous wastes, describe per instructions in the Appendix to Chapter 12, Title 22, California Code of Regulations, Division 4.5.

Item 12. Containers (No. and Type): Enter the number of containers for each waste and the appropriate abbreviation from Table I (below) for the type of container.

Table I—Types of Containers

DM =	Metal drums, barrels, kegs	TP =	Tanks, portable
DW =	Wooden drums, barrels, kegs	TT =	Cargo tanks (tank trucks)
DF =	Fiberboard or plastic drums, barrels, kegs	TC =	Tank cars
CW =	Wooden boxes, cartons, cases	DT =	Dump truck
CF =	Fiber or plastic boxes, cartons, cases	CY =	Cylinders
BA =	Burlap, cloth, paper, or plastic bags	CM =	Metal boxes, cartons, cases (including roll-offs)

Item 13. Total Quantity: Enter the total quantity of waste described on each line.

Item 14. Unit (Wt./Vol.): Enter the appropriate abbreviation from Table II (below) for the un measure.

Table II—Units of Measure

G =	Gallons (liquids only)	Y =	Cubic yards
P =	Pounds	L =	Liters (liqu
T =	Tons (2,000 lbs.)	K =	K

Item 15. Special Handling Instru space to indicate special transportation, formation. For international shipments, g and State) for those shipments destined fo me United States.

Item 16. Generator's Certification: es, and date the certification statement. If a mode other than high ay" should be lined out and the appropriate mode (rail, water, or air) inser . If another mode in addition to the highway mode is used, enter the appropriate m (e.g., and rail) in the space below.

INSTRUCTIONS FOR TRANSPORTERS

Item 17. Transporter 1 Acknowledgement of Receipt of Materials: Enter the name of the person accepting the waste on behalf of the first transporter. That person must acknowledge acceptance of the waste described on the Manifest by signing and entering the date of receipt.

Item 18. Transporter 2 Acknowledgement of Receipt of Materials: Enter, if applicable, the name of the person accepting the waste on behalf of the second transporter. That person must acknowledge acceptance of the waste described on the Manifest by signing and entering the date of receipt.

Note—International Shipments—Transporter Responsibilities: Exports—Transporters must sign and enter the date the waste left the U.S. in Item 15, and for RCRA hazardous waste exports, must ensure the waste is accompanied by an EPA Acknowledgement of Consent. Imports: RCRA hazardous waste shipments which are transported into the U.S. from a foreign country must be accompanied by a Manifest; non-RCRA hazardous waste shipments transported from a foreign country into or through California must also be accompanied by a Manifest. Transporters who transport any hazardous waste into the U.S. from abroad must assume generator responsibilities for completion of the Manifest [(40 CFR 263.10(c)(1)].

INSTRUCTIONS FOR OWNERS OR OPERATORS OF TREATMENT, STORAGE, OR DISPOSAL FACILITIES

Item 19. Discrepancy Indication Space: Refer to California Title 22, Section 66264.72 and 66265.12; 40 CFR 264.72 and 265.72 for help in completing this part. In this space you must note any significant discrepancy between the waste described on the Manifest and the waste you actually received. If you cannot resolve significant discrepancy within 15 days of receiving the waste, you must submit a letter to your DTSC Regional Administrator describing the discrepancy and your attempts to reconcile it. A copy of the Manifest at issue must be enclosed with the letter.

Item 20. Facility Owner or Operator: Certification of Receipt of Hazardous Materials Covered by This Manifest Except as Noted in Item 19. Print or type the name of the person accepting the waste on behalf of the owner or operator of the facility. That person must acknowledge acceptance of the waste described on the Manifest by signing and entering the date of receipt.

CALIFORNIA REQUIRED ITEMS

Generators to Enter:

B. If you will be paying the under Section 25174 of the Health and Safety Code directly to the Boar enter your Hazardous Waste Fee Account number issued by the under this section. This account number is a 12 charac r Board numbers you may hold are not valid for ing their account number to evade or defeat the not have an account number and are subject to 322-9477, Monday through Friday, between 8

e first vehicle used to transport the hazardous waste.

ompliance number of the vehicle used by Transporter 2, to

e category number. Select appropriate number from Table III. Review entire ing a number. For RCRA waste(s), enter the EPA's hazardous waste code from 40 3. To obtain federal assistance, call 800-424-9346 between 8:30 a.m. and 4:30 p.m. n time.

Enter chemical composition for each waste category. List components corresponding to the waste category entered.

TSDF Operator to Enter

G. Enter EPA ID number.

K. Enter waste handling code(s). Select appropriate code(s) from Table IV.

SAMPLE

Table III

California Restricted Waste

711. Liquids with cyanides ≥ 1,000 Mg./L
721. Liquids with arsenic ≥ 500 Mg./L
722. Liquids with cadmium ≥ 100 Mg./L
723. Liquids with chromium (VI) ≥ 500 Mg./L
724. Liquids with lead ≥ 500 Mg./L
725. Liquids with mercury ≥ 20 Mg./L
726. Liquids with nickel ≥ 134 Mg./L
727. Liquids with selenium ≥ 100 Mg./L
728. Liquids with thallium ≥ 130 Mg./L
731. Liquids with polychlorinated biphenyls ≥ 50 Mg./L
741. Liquids with halogenated organic compounds ≥ 1,000 Mg./L
751. Solids or sludges with halogenated organic compounds ≥ 1,000 Mg./Kg
791. Liquids with pH ≤ 2
792. Liquids with pH ≤ 2 with metals.
801. Waste potentially containing Dioxins.

California Nonrestricted wastes

Inorganics

121. Alkaline solution (pH ≥ 12.5) with metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc)
122. Alkaline solution without metals pH ≥ 12.5
123. Unspecified alkaline solution
131. Aqueous solution (2 < pH < 12.5) containing reactive anions (azide, bromate, chlorate, cyanide, fluoride, hypochlorite, nitrite, perchlorate, and sulfide anions)
132. Aqueous solution with metals (< restricted levels and see 121)
133. Aqueous solution with total organic residues 10 percent or more
134. Aqueous solution with total organic residues less than 10 percent
135. Unspecified aqueous solution
141. Off specification, aged, or surplus inorganics
151. Asbestos-containing waste
161. Fluid Catalytic Cracker waste
162. Other spent catalyst
171. Metal sludge (see 121)
172. Metal dust (see 121) and machining waste
181. Other inorganic solid waste

Organics

211. Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
212. Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
213. Hydrocarbon solvents (benzene, hexane, Stoddard, etc.)
214. Unspecified solvent mixture
221. Waste oil and mixed oil
222. Oil/water separation sludge
223. Unspecified oil-containing waste
231. Pesticide rinse water
232. Pesticides and other waste associated with pesticide production
241. Tank bottom waste
251. Still bottoms with halogenated organics
252. Other still bottom waste
261. Polychlorinated biphenyls and material containing PCBs
271. Organic monomer waste (includes unreacted resins)
272. Polymeric resin waste
281. Adhesives
291. Latex waste
311. Pharmaceutical waste
321. Sewage sludge
322. Biological waste other than sewage sludge
331. Off-specification, aged, or surplus organics
341. Organic liquids (nonsolvents) with halogens
342. Organic liquids with metals (see 121)
343. Unspecified organic liquid mixture
351. Organic solids with halogens
352. Other organic solids

Sludges

411. Alum and gypsum sludge
421. Lime sludge
431. Phosphate sludge
441. Sulfur sludge
451. Degreasing sludge
461. Paint sludge
471. Paper sludge/pulp
481. Tetraethyl lead sludge
491. Unspecified sludge waste

Miscellaneous

511. Empty pesticide containers 30 gallons or more
512. Other empty containers 30 gallons or more
513. Empty containers less than 30 gallons
521. Drilling mud
531. Chemical toilet waste
541. Photochemicals/photoprocessing waste
551. Laboratory waste chemicals
561. Detergent and soap
571. Fly ash, bottom ash, and retort ash
581. Gas scrubber waste
591. Baghouse waste
611. Contaminated soil from site clean-ups
612. Household wastes
613. Auto shredder waste

Table IV

01	Recycle	03	Landfill	06	Surface Impoundment	14	Transfer Station	16	Treatment Pond (excludes evaporation)
02	Injection Well	04	Land Application	07	Thermal Treatment (includes incineration)	15	Tank Treatment	99	Other

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Health and Safety Code

Humane Care of Animals

1650.

The public health and welfare depend on the humane use of animals for scientific advancement in the diagnosis and treatment of human and animal diseases, for education, for research in the advancement of veterinary, dental, medical and biologic sciences, for research in animal and human nutrition, and improvement and standardization of laboratory procedures of biologic products, pharmaceuticals and drugs.

1651.

The State Department of Health Services shall administer the provisions of this chapter.

Every provision of this chapter shall be liberally construed to protect the interests of all persons and animals affected.

As used in this chapter, "person" includes: laboratory, firm, association, corporation, copartnership, and educational institution.

As used in this chapter, "board" or "department" means the State Department of Health Services.

1660.

The department shall make and promulgate, and may thereafter modify, amend or rescind, reasonable rules and regulations to carry out the purposes of this chapter, including the control of the humane use of animals for the diagnosis and treatment of human and animal diseases, for research in the advancement of veterinary, dental, medical and biologic sciences, for research in animal and human nutrition, and for the testing and diagnosis, improvement and standardization of laboratory specimens, biologic products, pharmaceuticals and drugs. Such rules and regulations shall include requirements for satisfactory shelter, food, sanitation, record keeping, and for the humane treatment of animals by persons authorized by the board to raise, keep or to use animals under the provision of this chapter. The department shall not make or promulgate any rule compelling the delivery of animals for the purpose of research, demonstration, diagnosis, or experimentation.

1662.

The department is hereby authorized to inspect any premises or property on or in which animals are kept for experimental or diagnostic purposes, for the purpose of investigation of compliance with the rules and regulations adopted hereunder. Such inspection or other method of control shall be enforced only by employees of the department and such power and authority may not be delegated to any other persons or agency.

Retrograde Material

25121.5.

"Retrograde material" means any hazardous material which is not to be used, sold, or distributed for use in an originally intended or prescribed manner or for an originally intended or prescribed purpose and which meets any one or more of the following criteria:

(a) Has undergone chemical, biochemical, physical, or other changes due to the passage of time or the environmental conditions under which it was stored.

(b) Has exceeded a specified or recommended shelf life.

(c) Is banned by law, regulation, ordinance, or decree.

(d) Cannot be used for reasons of economics, health or safety, or environmental hazard.

Repeal of Requirement for Obtaining an Extremely Hazardous Waste Disposal Permit

25153.

The offsite storage, treatment, transportation, and disposal of extremely hazardous waste is subject to the same requirements specified in this chapter that are applicable to hazardous waste and the department shall not require any special or additional permits for the offsite handling of extremely hazardous waste.

25205.7(o).

Any person producing or transporting extremely hazardous waste shall pay a fee of two hundred dollars ($200) per calendar year, in addition to any other fee imposed by this section. The fee shall be collected annually.

Transporting Hazardous Waste

25163.

(c) Persons transporting hazardous wastes to a permitted hazardous waste facility for transfer, treatment, recycling, or disposal, which wastes do not exceed a total volume of five gallons or do not exceed a total weight of 50 pounds, are exempt from the requirements . . . concerning possession of a manifest while transporting hazardous waste, upon meeting all of the following conditions:

(1) The hazardous wastes are transported in closed containers and packed in a manner that prevents containers from tipping, spilling, or breaking during the transporting.

(2) Different hazardous waste materials are not mixed within a container during the transporting.

(3) If the hazardous waste is extremely hazardous waste or acutely hazardous waste, the extremely hazardous waste or acutely hazardous waste was not generated in the course of any business and is not more than 2.2 pounds.

(4) The person transporting the hazardous waste is the producer of that hazardous waste, and the person produces

not more than 100 kilograms of hazardous waste in any month.

(5) The person transporting the hazardous waste does not accumulate more than a total of 1,000 kilograms of hazardous waste onsite at any one time. . . .

(e) It is unlawful for any person to transport hazardous waste in any truck, trailer . . . not inspected by the Department of the California Highway Patrol. . . .

25163.1.

The Department shall not adopt any regulations requiring a person hauling hazardous wastes who is not in the business of hauling hazardous wastes or who is not hauling these wastes as part of, or incidental to, any business to obtain the registration specified if that person meets the conditions specified in subsection (c) of Section 25163.

Hazardous Materials Release Response Plans and Inventory

[The following is a *summary* of the relevant sections of Chapter 6.95. *Ed.*]

25500.

In order to protect public health and safety and the environment, it is necessary to establish business and area plans relating to the handling and release of hazardous materials. Basic information on location, type, quantity, and the health risks of hazardous materials handled, used, stored, or disposed of is necessary to prevent or mitigate the damage to the health and safety of persons and the environment from the release or threatened release of hazardous materials into the workplace and environment.

25502.

Every county is required, through a designated administering agency, to implement the establishment of business and area plans as to the handling of hazardous materials and assure availability and access of information to emergency rescue personnel and other appropriate entities. A city may assume that responsibility within its boundaries, coordinating its activities with the county in which it is located.

25503.3

Businesses handling hazardous materials shall annually complete a hazardous materials reporting form and submit it to the administering agency.

25503.5

Any business which handles a quantity of hazardous material which at any time during the year is equal to or greater than a total weight of 500 lbs or a total volume of 55 gallons, or 200 cubic feet at standard temperature and pressure for compressed gas, shall establish and implement a business plan for emergency response to a release or threatened release of a hazardous material.

25504.

Business plans shall include a chemical inventory as required by Section 25509, emergency response plans in the event of a reportable release or threatened release of hazardous material, and training for all new employees and annual training regarding release or threatened release of hazardous materials.

25505.

Each handler shall submit its business plan to the administering agency.

25507.

Handlers shall immediately report any release or threatened release to the administering agency and provide fire, health, safety, and/or rescue personnel access to the facilities.

25509.

(a) The annual inventory form shall include, but shall not be limited to, information on all of the following which are handled in quantities equal to or greater than the quantities specified in Section 25503.5:

(1) A listing of the chemical name and common names of every hazardous substance or chemical product handled by the business.

(2) The category of waste, including the general chemical and mineral composition of the waste listed by probable maximum and minimum concentrations, of every hazardous waste handled by the business.

(3) A listing of the chemical name and common names of every other hazardous material or mixture containing a hazardous material handled by the business which is not otherwise listed, pursuant to paragraph (1) or (2).

(4) The maximum amount of each hazardous material or mixture containing a hazardous material disclosed in paragraphs (1), (2), and (3) which is handled at any one time by the business over the course of the year.

(5) Sufficient information on how and where the hazardous materials disclosed in paragraphs (1), (2), and (3) are handled by the business to allow fire, safety, health, and other appropriate personnel to prepare adequate emergency responses to potential releases of the hazardous materials.

(6) The name and phone number of the person representing the business and able to assist emergency personnel in the event of an emergency involving the business during nonbusiness hours.

APPENDIX C

REIMBURSEMENT FOR REMOVAL AND DISPOSAL OF CHEMICALS

On July 28, 1988, the Commission of State Mandates determined that the following costs incurred by school districts to implement *Education Code* Section 49411 are reimbursable: (1) the cost of complying with guidelines for the regular removal and disposal of all chemicals whose shelf life has elapsed; and (2) the cost of certifying to the Superintendent of Public Instruction whether the district is in compliance with the guidelines.

For each eligible claimant (which certified its compliance with the guidelines by June 30, 1988), reimbursable costs are all costs for the regular removal and disposal of chemicals that have not yet reached a "retrograde" condition (*Health and Safety Code* Section 25121.5; see the list under section G of this appendix) but still pose a significant threat to the health and safety of teachers, staff, and students, as established by the most current Department of Education guidelines.

The actual costs for one fiscal year shall be included in each claim. The estimated costs for the subsequent year may be included in the same claim, if applicable. All claims for the reimbursement of costs shall be submitted within 120 days of notification by the State Controller of the enactment of the claims bill.

If the total costs for a given fiscal year do not exceed $200, no reimbursement shall be allowed, except as otherwise allowed by *Government Code* Section 17564.

A. Reimbursable Costs

Reimbursement is available for elementary, secondary, and unified school districts. The costs of ongoing removal and disposal may include, but are not limited to, the following:

1. Salaries and benefits of personnel at school sites, district offices, and county offices of education, both certificated and classified, who perform any duties related to compliance with this mandate; salaries and benefits of substitute employees who provided coverage for employees performing duties related to said mandates.
2. Consultant fees for preparation of initial chemical inventories, preparation of chemical profile inventories for chemical disposal purposes, supervision (monitoring) of contractor during on-site related activities.
3. All contractor fees/charges for review and computer entry of inventories.
4. All costs for the regular removal and disposal of chemicals that have not yet reached a "retrograde" condition (*Health and Safety Code* Section 25121.5) but still pose a significant threat to the health and safety of teachers, staff, and students, as established by the most current Department of Education guidelines. The costs of regular removal and disposal may include, but are not limited to, the following:
    a. Consultant fees for supervision of lab-packing, loading, and so forth.
    b. Contractor fees and charges for the packing of laboratory chemicals and transportation of waste and the charges associated with the final disposition of the waste material, including treatment, recycling, incineration, and landfill disposal.
    c. All costs incurred by the school district for packing the chemicals in-house, using district personnel. These costs may include disposable body suits; protective gloves; shipping containers (drums, liners, etc.) approved by the Department of Transportation (DOT); absorbent materials for spill containment and lab-packing; DOT-approved shipping labels for DOT containers; publications used for reference by and training of district personnel, including this document, *Science Safety Handbook for California Public Schools*.
    d. Other miscellaneous costs incurred by the district that are imposed by local, state, and federal governmental agencies. These costs are normally charged by the particular agency as taxes or surcharges, such as excise tax fees, generator fees, and superfund taxes. These costs are reimbursable only to the extent that they are incurred for the disposal of chemicals that have not yet reached a "retrograde" condition, as specified above.

B. Nonreimbursable Activities

All costs incurred after June 30, 1988, associated with the removal of chemicals that meet the definition of "retrograde materials," as defined in *Health and Safety Code* Section 25121.5, are nonreimbursable.

C. Claim Preparation

Each claim for reimbursement pursuant to this mandate must be filed in time and must set forth a list of each item for which reimbursement is claimed under this mandate. The claim must contain the following information:

1. Description of activity
2. Supporting documentation

Claimed costs should be supported by the following information:

a. *Employee salaries and benefits.* Identify the employee(s) and show the classification of the employee(s) involved; describe the mandated functions performed; and specify the number of hours devoted to each function, the productive hourly rate, and the related benefits.

b. *Services and supplies.* Only those expenditures that can be identified as a direct cost of the mandate may be claimed. Make a list of the cost of materials that have been consumed or expended specifically for the purpose of this mandate.

c. *Allowable overhead cost.* School districts may use the "J-380" nonrestrictive indirect cost rate. County offices of education may use the "J-580" rate.

D. Supporting Data

For auditing purposes, all costs claimed must be traceable to source documents or work sheets that show evidence of the validity of such costs. These documents must be kept on file by the agency submitting the claim for a period of not less than three years from the date of the final payment of the claim, pursuant to this mandate, and made available on the request of the State Controller or his or her agent.

E. Offsetting Savings and Other Reimbursements

Any offsetting savings the claimant experiences as a direct result of this statute must be deducted from the costs claimed. In addition, reimbursement for this mandate received from any source (e.g., federal, state, or local agencies) shall be identified and deducted from this claim. Reimbursement for taxes paid for the removal and disposal of chemicals to comply with the certification requirement of Chapter 1107, Statutes of 1984, which taxes were waived by the Department of Health Services, must be sought pursuant to *Government Code* Section 16302.1.

F. Required Certification

The following certification must accompany the claim:

I DO HEREBY CERTIFY under penalty of perjury:

THAT the foregoing is true and correct;

THAT Sections 1090 through 1096, inclusive, of the *Government Code* and other applicable provisions of the law have been complied with; and

THAT I am the person authorized by the local agency to file claims for funds with the State of California.

Signature of Authorized Representative Date

Title Telephone

G. Chemicals to Be Removed from School Science Laboratories

The following list identifies three groups of chemicals:

1. Those chemicals included on lists of hazardous chemicals that were recommended for removal and disposal in the 1987 edition of this handbook and which, at this time, are considered "retrograde materials" are identified with an asterisk (*). (See definition of retrograde materials in Appendix B, *Health and Safety Code* Section 25125.5.) The costs for disposal of these "retrograde materials" are *not* considered reimbursable.
2. Chemicals that have been added to the previous lists of hazardous chemicals recommended for immediate or prompt removal and disposal (see tables 1, 2, and 3) are identified with two asterisks (**). The costs for disposal of these chemicals *are* considered reimbursable.
3. Chemicals that are subject to regular removal and disposal, on approaching their estimated shelf life, because they pose a significant threat to the health and safety of teachers, staff, and students but have not yet reached a "retrograde" condition *have no asterisk.* The costs for disposal of these materials *are* reimbursable.

Acetic Acid (glacial)
*2-Acetylaminofluorine
*4-Aminodiphenyl
Acetone
**Acrylamide
Aluminum (powder)
Aluminum Chloride
Aluminum Sulfate
Ammonium Carbonate
Ammonium Chloride
Ammonium Hydroxide
Ammonium Nitrate
Ammonium Persulfate
*Aniline
**Antimony
*Arsenic compound (any)
*Arsenic powder
*Arsenic Trioxide
*Asbestos
Barium (soluble compounds)
Barium Chloride
Barium Hydroxide
Barium Nitrate
Bismuth and alloys (powder)
*Benzene
*Benzidine (and salts)

*Benzoyl Peroxide
**Beryllium
**Beryllium Compounds
Boric Acid
**Bromine
Butyl Alcohols
*Cadmium powder
*Cadmium salts
**Calcium Carbide
Calcium Chloride
Calcium Hydroxide
Calcium Hypochlorite
Calcium metal
Calcium Nitrate
Calcium Oxide
Camphor
*Carbon Disulfide
*Carbon Tetrachloride
*Chloroform
*Chromium (VI) Oxide
**All hexavalent chromium compounds
**Cobalt
Cobalt Chloride
**Cobalt II Oxide
Cobalt Nitrate
Cobalt Sulfate
Cupric Chloride
Cupric Nirate
Cupric Oxide
Cupric Sulfate
Cyclohexane
**p-Dichlorobenzene
*3,3-Dichlorobenzidene (and salts)
*Diisopropyl Ether (if stored more than 1 year)
*Dimethyl Amine
*4-Dimethylaminoazobenzene
**Ethidium Bromide
Ethyl Acetate
Ethyl Alcohol
*Ethyl Ether/Diethyl Ether (if stored more than 1 year)
*Ethylene Dichloride
*Ethylene Oxide
*Ethyleneimine
Ferric Chloride
Ferric Nitrate
Ferrous Sulfate
**Formaldehyde
Formic Acid
Hexane
*Hydrazine (anhydrous)
Hydrochloric Acid
*Hydrofluoric Acid
**Hydrogen Peroxide (35%)
Iodine
Isobutyl Alcohol
Isopropyl Alcohol
Kerosene
**Lead (powder)
**Lead Acetate
*Lead Arsenate
**Lead Carbonate
**Lead Chloride
**Lead Nitrate
**Lead Oxide
**Lead Peroxide (dioxide)
**Lead Sulfate
**Lead Sulfide
Lithium Nitrate
Magnesium Chloride
Magnesium Metal (powder/ ribbon)
Magnesium Nitrate
Magnesium Oxide
Manganese Dioxide
Manganous Sulfate
**Mercurous/Mercuric Nitrate
**Mercury metal
**Mercury compounds
Methanol
Methyl Ethyl Ketone
Methyl Cellulose
*Methylchloromethyl Ether
*4-4-Methylene bis (2-chloroanaline)
*Methylene Chloride
*Alpha-Naphthylamine
*Beta-Naphthylamine
**Nickel compounds
*Nickel powder
*4-Nitrobiphenyl
**Nicotine
Nitric Acid
*Nitrogen Triiodide
Oxalic Acid
Pentane
*Perchloric Acid
**Phenol (carbolic acid)
**Phosphorous (red)
*Phosphorous (yellow/white)
*Picric Acid
Potassium Bromide
**Potassium Chlorate
Potassium Hydroxide
Potassium Iodide
*Potassium metal
Potassium Nitrate
Potassium Permanganate
Resorcinol
*Beta-Propiolactone
*Sodium Arsenate
*Sodium Arsenite
*Sodium Azide
Sodium Chlorate
Sodium Chromate
Sodium Hypochlorite
Sodium metal
Sodium Nitrate
Sodium Peroxide
Sodium Thiosulfate
Styrene
Sulfur
Sulfuric Acid
**Toluene
Turpentine
*Vinyl Chloride
Xylene
Zinc, metal powder
Zinc Nitrate

Appendix D

Science Classroom First-Aid and Safety Materials

Adhesive bandages

Antiseptic

Antiseptic applicators

Aprons

Bucket of sand or commercial absorbent—to smother alkali fires, dam around spills, reduce slippery conditions, and so on

Cotton

Earthenware crock—for disposal of solid chemicals (If needed, have several crocks labeled to prevent mixing of incompatible chemicals.)

Fume hoods, where appropriate

Mercury clean-up chemicals (e.g., zinc dust, mercury "sponges"*)

Neutralizing agents:
  Acetic acid (30% [5 M] solution)—for neutralizing spilled bases

  Sodium bicarbonate (saturated solution)—for neutralizing spilled acids

Rubber and nitrile gloves

Safety equipment:
  Eyewash/shower unit
  Face shields
  Fire blanket
  Fire extinguisher(s), multipurpose (2A-10B, C)
  Safety shield

Splash-proof goggles—for every student, instructor, and visitor

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This list is purposely conservative because the school health office (or school nurse) should have more extensive supplies.

*See Chapter 5, section K, "Use of Mercury."

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Sample
Accident Report

School: ____________________

Staff completing report: ____________________ Room: ____________

Date and time of incident: ____________________

Location of the incident:

____

Person(s) involved in the incident:

Staff	Student

Description of the incident:

____

____

____

Immediate action in responding to the emergency:

____

____

____

Action taken (or required) to prevent such incidents in the future:

____

____

____

Witnesses to the incident: ____________________

____

____

Date/time of report	Signature

APPENDIX E

REGIONAL POISON CENTERS

1. Chevron Emergency Information Center
100 Chevron Way
Richmond, CA 94802-0627
(Business) (510) 242-2689 (Facilities Operation)
(Emergency) (800) 231-0623
(510) 231-2473
(510) 231-0623
(510) 242-3333

2. Central California Regional Poison Control Center
Valley Children's Hospital
3151 N. Millbrook
Fresno, CA 93703
(Business) (209) 241-6040
(Emergency) (800) 346-5922 (central California only)
(209) 445-1222
(FAX) (209) 241-6050

3. Los Angeles Regional Drug and Poison Information Center
LAC-USC Medical Center
1200 N. State St., Rm. GH 1107
Los Angeles, CA 90033
(Business) (213) 226-2246
(Emergency) (213) 222-8086 (Physicians)
(213) 222-3212 (Consumers)
(800) 825-2722 (Professionals outside 213 area code)
(800) 777-6476 (Consumers outside 213 area code)
(FAX) (213) 226-4191
Special note: Serves only the following counties: Los Angeles, Ventura, Santa Barbara, San Bernardino, Inyo

4. San Diego Regional Poison Center
UCSD Medical Center
200 W. Arbor Dr.
San Diego, CA 92103-8925
(Business) (619) 543-3666
(Emergency) (619) 543-6000
(800) 876-4766 (California only)
(FAX) (619) 692-1867

5. San Francisco Bay Area Regional Poison Control Center
San Francisco General Hospital
1001 Potrero Ave.
Bldg. 80, Rm. 230
San Francisco, CA 94110
(Business) (415) 206-5524
(Emergency) (800) 523-2222 (Northern California)
(FAX) (415) 821-8513

APPENDIX F

SAMPLE

SAFETY REGULATIONS FOR SCIENCE STUDENTS

While working in the science laboratory, you will have certain important responsibilities that do not apply to other classrooms. You will be working with materials and apparatus which, if handled carelessly or improperly, have the potential to cause injury or discomfort to someone else as well as yourself.

A science laboratory can be a safe place in which to work if you, the student, are foresighted, alert, and cautious. The following practices will be followed:

1. Report any accident to the teacher immediately, no matter how minor, including reporting any burn, scratch, cut, or corrosive liquid on skin or clothing.
2. Prepare for each laboratory activity by reading all instructions before coming to class. Follow all directions implicitly and intelligently. Make note of any modification in procedure given by the instructor.
3. Any science project or individually planned experiment must be approved by the teacher.
4. Use only those materials and equipment authorized by the instructor.
5. Inform the teacher immediately of any equipment not working properly.
6. Clean up any nonhazardous spill on the floor or work space immediately.
7. Wear appropriate eye protection, as directed by the instructor, whenever you are working in the laboratory. Safety goggles must be worn during hazardous activities involving caustic/corrosive chemicals, heating of liquids, and other activities that may injure the eyes.
8. Splashes and fumes from hazardous chemicals present a special danger to wearers of contact lenses. Therefore, students should preferably wear regular glasses (inside splash-proof goggles, when appropriate) during all class activities or purchase personal splash-proof goggles and wear them whenever exposure to chemicals or chemical fumes is possible.
9. Students with open skin wounds on hands must wear gloves or be excused from the laboratory activity.
10. Never carry hot equipment or dangerous chemicals through a group of students.
11. Check labels and equipment instructions carefully. Be sure correct items are used in the proper manner.
12. Be aware if the chemicals being used are hazardous. Know where the material safety data sheet (MSDS) is and what it indicates for each of the hazardous chemicals you are using.
13. Never taste anything or touch chemicals with the hands, unless specifically instructed to do so.
14. Test for odor of chemicals only by waving your hand above the container and sniffing cautiously from a distance.
15. Eating or drinking in the laboratory or from laboratory equipment is not permitted.
16. Use a mechanical pipette filler (never the mouth) when measuring or transferring small quantities of liquid with a pipette.
17. When heating material in a test tube, do not look into the tube or point it in the direction of any person during the process.
18. Never pour reagents back into bottles, exchange stoppers of bottles, or lay stoppers on the table.
19. When diluting acids, always pour acids into water, never the reverse. Combine the liquids slowly while stirring to distribute heat buildup throughout the mixture.
20. Keep hands away from face, eyes, and clothes while using solutions, specimens, equipment, or materials in the laboratory. Wash hands as necessary and wash thoroughly at the conclusion of the laboratory period.
21. To treat a burn from an acid or alkali, wash the affected area immediately with plenty of running water. If the eye is involved, irrigate it at the eyewash station without interruption for 15 minutes. Report the incident to your instructor immediately.
22. Know the location of the emergency shower, eyewash and facewash station, fire blanket, fire extinguisher, fire alarm box, and exits.
23. Know the proper fire- and earthquake-drill procedures.
24. Roll long sleeves above the wrist. Long, hanging necklaces, bulky jewelry, and excessive and bulky clothing should not be worn in the laboratory.
25. Confine long hair during a laboratory activity.
26. Wear shoes that cover the toes, rather than sandals, in the laboratory.
27. Keep work areas clean. Floors and aisles should be kept clear of equipment and materials.
28. Light gas burners only as instructed by the teacher. Be sure no volatile materials (such as alcohol or acetone) are being used nearby.
29. Use a burner with extreme caution. Keep your head and clothing away from the flame and turn it off when not in use.
30. Use a fire blanket (stop, drop, and roll) to extinguish any flame on a person.

31. Dispose of laboratory waste as instructed by the teacher. Use separate, designated containers (not the wastebasket) for the following:
    - Matches, litmus paper, wooden splints, toothpicks, and so on
    - Broken and waste glass
    - Rags, paper towels, or other absorbent materials used in the cleanup of flammable solids or liquids
    - Hazardous/toxic liquids and solids
32. Place books, purses, and such items in the designated storage area. Take only laboratory manuals and notebooks into the working area.
33. Students are not permitted in laboratory storage rooms or teachers' workrooms without the approval of the teacher.
34. To cut small-diameter glass tubing, use a file or tubing cutter to make a deep scratch. Wrap the tubing in a paper towel before breaking the glass away from you with your thumbs. Fire polish all ends.
35. When bending glass, allow time for the glass to cool before further handling. Hot and cold glass have the same visual appearance. Determine whether an object is hot by bringing the back of your hand close to the object.
36. Match hole sizes and tubing when inserting glass tubing into a stopper. If necessary, expand the hole first by using an appropriate size cork borer. Lubricate the stopper hole and glass tubing with water or glycerin to ease insertion, using towels to protect the hand. Carefully twist (never push) glass tubing into stopper holes.
37. Remove all broken glass from the work area or floor as soon as possible. Never handle broken glass with bare hands; use a counter brush and dustpan.
38. Report broken glassware, including thermometers, to the instructor immediately.
39. Operate electrical equipment only in a dry area and with dry hands.
40. When removing an electrical plug from its socket, pull the plug, not the electrical cord.
41. Treat all animals in the science laboratory humanely; that is, with respect and consideration for their care.
42. Always approach laboratory experiences in a serious and courteous manner.
43. Always clean the laboratory area before leaving.
44. Students and teacher wash hands with soap and water before leaving the laboratory area.

Note: Persistent or willful violation of the regulations will result in the loss of laboratory privileges and possible dismissal from the class.

Please see the "Student Science Safety Contract" on the following page.

Student Science Safety Contract

School: ____________________ Teacher: ______________ Date: ________

Student's name: ____

The student has received specific instruction regarding the use, function, and location of the following:

Aprons, gloves ☐
Chemical-spill kit ☐
Eye-protective devices (goggles, face shield, safety shield) ☐
Eyewash fountain, drench spray, and drench shower ☐
Fire extinguisher ☐
Fire blanket ☐
First-aid kit ☐
Heat sources (burners, hot plate, microwave) and techniques in their use ☐
Material safety data sheets (MSDSs) ☐
Waste-disposal containers for glass, chemicals, matches, paper, wood ☐

The student will abide by the "Safety Regulations for Science Students" to prevent accidents and injury to herself or himself and others and will:

- Follow all additional instructions given by the teacher.
- Conduct herself or himself in a responsible manner at all times in the laboratory.

List below any special allergies or sensitivities (e.g., to plants, animals, pollen, foods, chemicals, bee stings) that may affect the student's safety in the laboratory or on field trips:

____

Check this box if the student wears contact lenses: ☐

Student's Statement

I have in my possession and have read the "Safety Regulations for Science Students" (pages 143–44) and agree to abide by them at all times while in the laboratory. I have received specific safety instruction as indicated above.

______________________________ ______________

Signature of student Date

Parent's or Guardian's Statement

I have read the "Safety Regulations for Science Students" (pages 143–44) and give my consent for the student who has signed the preceding statement to engage in laboratory activities using a variety of science equipment and materials, including those described. I pledge my cooperation in urging that she or he observe the safety regulations prescribed.

______________________________ ______________

Signature of parent or guardian Date

Return the completed and signed form to ____________________ *by* __________

APPENDIX G

SAMPLE

SCIENCE LABORATORY SAFETY TEST

The following questions were developed to provide teachers with suggested questions from which they might prepare tests for specific courses. The list of questions is not intended to be comprehensive; each teacher is expected to supplement the sample items. Note that although there are only 40 questions in the sample test, the answer sheet that follows the questions has spaces for 100 items. Thus the answer sheet may be used for a variety of teacher-developed safety tests.

1. If you see something in the classroom or laboratory that is dangerous, tell the teacher—
   a. When you have time
   b. At once
   c. After class
   d. After school

2. Rags or paper towels with flammable liquids or solids on or in them must be put in—
   a. A cardboard box
   b. A metal or crockery container with a lid
   c. A wastebasket
   d. A trash can

3. Any spill on the floor can cause an accident. Always clean it up—
   a. At once
   b. During clean-up time
   c. When you have time
   d. At the end of the period

4. Alcohol, acetone, and other volatile materials that can burn easily should never be used near—
   a. Another person
   b. An open flame
   c. A laboratory counter
   d. A work table

5. When you work with laboratory chemicals and Bunsen burners, long hair must be—
   a. Cut off
   b. Held with both hands
   c. Kept out of the way by wearing a band, hat, or hairnet
   d. Combed nicely

6. When you work with laboratory chemicals, equipment, or burners, you must wear—
   a. Loose clothes
   b. Goggles
   c. Contact lenses
   d. Loose jewelry

7. If you are hurt (cut, burned, and so on) tell the—
   a. Nurse at once
   b. Teacher at once
   c. Class at once
   d. Doctor after school

8. Whenever you are in the classroom or laboratory, you should wear—
   a. Sandals
   b. Closed shoes
   c. Open-toed shoes
   d. No shoes

9. If you think there is something wrong with a piece of equipment you are using, stop, turn it off, and tell—
   a. The class leader
   b. The teacher
   c. Another student
   d. The custodian

10. If you break a piece of glassware or other equipment, tell the teacher—
    a. The next period
    b. At clean-up time
    c. At once
    d. Never

11. All floors, aisles, and passageways should be kept clear of—
    a. Teacher and students
    b. Laboratory equipment and chemicals
    c. Laboratory equipment only
    d. Chemicals only

12. If you see a fire in an apparatus assembly or a burning liquid, such as alcohol, it is best to put it out with—
    a. The fire blanket
    b. Water from the sink
    c. Your coat
    d. The ABC fire extinguisher

13. To put out a fire in a person's clothing, use—
    a. The fire blanket
    b. A handy chemical
    c. The wind from running
    d. The CO_2 fire extinguisher

14. The correct way to move about the classroom or laboratory is to—
    a. Run
    b. Walk
    c. Hurry
    d. Skip

15. Helping to clean up the classroom or laboratory is the job of—
    a. New students
    b. Old students
    c. Each student
    d. The teacher

16. When you use laboratory equipment or chemicals, you should give the procedure all of your—
    a. Interest
    b. Attention
    c. Effort
    d. All of these (a, b, and c)

17. Chemicals, small parts, glassware, and stirring rods are not to be —
    a. Used in the laboratory
    b. Put in your mouth
    c. Put on the bench
    d. Taken from boxes

18. To prevent accidents during laboratory activities with chemicals and equipment, you should—
    a. Use shortcuts
    b. Follow your teacher's directions
    c. Hurry ahead of teachers
    d. Ask someone else to do the work

19. Playing (as opposed to working) in the laboratory or bothering another person is—
    a. Always against the rules
    b. All right
    c. Not dangerous
    d. All right (if you are working)

20. To be able to put out a fire quickly and safely, you should know—
    a. How to use extinguishers
    b. Where the extinguishers are located
    c. Which extinguisher is used for each class of fire
    d. All of the above

21. If flammable liquids, such as alcohol, are spilled, you should first—
    a. Let them dry up
    b. Use a fire extinguisher
    c. Tell the teacher
    d. Pour water on them

22. Before you touch an electrical switch, plug, or outlet—
    a. Your hands must be dry
    b. Ask the custodian
    c. Your hands must be clean
    d. Ask the nurse

23. Eyeglasses do not provide as much protection as—
    a. A face shield
    b. Safety glasses
    c. Splash-proof goggles
    d. Any of these (a, b, or c)

24. Laboratory aprons, when provided, are for—
    a. The protection of you and your clothes
    b. Wiping your hands on
    c. Others to hang up
    d. When you are wearing your best clothes

25. Cabinet drawers and doors that are left open cause a hazard and should be—
    a. Walked around
    b. Closed by you
    c. Left alone
    d. Closed by the teacher only

26. If there is a fire in the laboratory, notify the teacher at once; then prepare to—
    a. Evacuate the building or laboratory
    b. Remove flammable materials
    c. Open the windows
    d. Rapidly clean the laboratory

27. All chemicals should be stored in—
    a. Tin cans
    b. Dark brown bottles
    c. Clear glass bottles
    d. Properly labeled containers

28. When preparing dilute solutions of an acid, carefully pour—
    a. The acid into water c. Water into the acid
    b. The acid into the container d. Both liquids at once

29. If acid gets on your skin or clothes, wash at once with—
    a. Sulfuric acid c. Water
    b. Soap d. Oil

30. Small quantities of spilled acids can be made safe with—
    a. Gasoline c. Water
    b. Alcohol d. Sodium bicarbonate solution

31. Small amounts of spilled bases can be neutralized and made safe with—
    a. Gasoline c. Water
    b. Alcohol d. Dilute acetic acid solution (vinegar)

32. You must wear approved eye protection while working in the laboratory—
    a. To improve your vision c. To avoid myopia
    b. Sometimes d. Whenever the laboratory instructions tell you to

33. Disturbing other students while they are working in the laboratory is—
    a. Helpful c. Dangerous
    b. Poor manners d. The quickest way to do a job

34. You should prepare for each laboratory activity by reading all instructions—
    a. After school c. Before you start to work
    b. While you are working d. Next week

35. When measuring small amounts of liquids with a pipette, draw the liquid into the tube by using—
    a. Your mouth c. A mechanical pipette filler
    b. Your thumb d. The palm of your hand

36. When heating substances in a test tube, be sure the open end of the tube points toward—
    a. Yourself c. Your partner
    b. No one d. A classmate

37. After heating glass tubing to bend it, the soonest you may safely handle the tubing is—
    a. Within 30 seconds c. After school
    b. After you are sure it is cool d. The next day

38. To insert glass tubing into a rubber stopper, you should (after fire polishing and cooling)—
    a. Lubricate with water or glycerin c. Twist carefully
    b. Use a towel for protection d. All of these (a, b, and c)

39. To remove an electrical plug from its socket, you should—
    a. Pull the plug itself c. Pull on the appliance
    b. Pull on the cord d. None of these (a, b, or c)

40. On the back of your answer sheet, draw a diagram of your science laboratory or classroom and label the location of the following:
    Fire blanket
    Fire extinguisher
    Exits
    Safety goggles storage (or dispensing area)
    Eyewash station
    Safety shower
    Closest fire alarm
    Waste-disposal containers (label the type of waste for which each container is suitable)

Student's Answer Sheet for Science Laboratory Safety Test

Name ______ Period ______ Test No. ______ Score ______

Directions: Read each statement in your safety test. Under each question you will find four answers. Choose the one correct answer and fill in the box that represents the answer.

Example: Read question 1. The correct answer is "b. at once." Note that the "b" box beside number 1 (see example below) is darkened. Continue marking all the answers in this manner.

	a	b	c	d		a	b	c	d		a	b	c	d
1.	☐	■	☐	☐	39.	☐	☐	☐	☐	77.	☐	☐	☐	☐
2.	☐	☐	☐	☐	40.	☐	☐	☐	☐	78.	☐	☐	☐	☐
3	☐	☐	☐	☐	41.	☐	☐	☐	☐	79.	☐	☐	☐	☐
4.	☐	☐	☐	☐	42.	☐	☐	☐	☐	80.	☐	☐	☐	☐
5.	☐	☐	☐	☐	43.	☐	☐	☐	☐	81.	☐	☐	☐	☐
6.	☐	☐	☐	☐	44.	☐	☐	☐	☐	82.	☐	☐	☐	☐
7.	☐	☐	☐	☐	45.	☐	☐	☐	☐	83.	☐	☐	☐	☐
8.	☐	☐	☐	☐	46.	☐	☐	☐	☐	84.	☐	☐	☐	☐
9.	☐	☐	☐	☐	47.	☐	☐	☐	☐	85.	☐	☐	☐	☐
10.	☐	☐	☐	☐	48.	☐	☐	☐	☐	86.	☐	☐	☐	☐
11.	☐	☐	☐	☐	49.	☐	☐	☐	☐	87.	☐	☐	☐	☐
12.	☐	☐	☐	☐	50.	☐	☐	☐	☐	88.	☐	☐	☐	☐
13.	☐	☐	☐	☐	51.	☐	☐	☐	☐	89.	☐	☐	☐	☐
14.	☐	☐	☐	☐	52.	☐	☐	☐	☐	90.	☐	☐	☐	☐
15.	☐	☐	☐	☐	53.	☐	☐	☐	☐	91.	☐	☐	☐	☐
16.	☐	☐	☐	☐	54.	☐	☐	☐	☐	92.	☐	☐	☐	☐
17.	☐	☐	☐	☐	55.	☐	☐	☐	☐	93.	☐	☐	☐	☐
18.	☐	☐	☐	☐	56.	☐	☐	☐	☐	94.	☐	☐	☐	☐
19.	☐	☐	☐	☐	57.	☐	☐	☐	☐	95.	☐	☐	☐	☐
20.	☐	☐	☐	☐	58.	☐	☐	☐	☐	96.	☐	☐	☐	☐
21.	☐	☐	☐	☐	59.	☐	☐	☐	☐	97.	☐	☐	☐	☐
22.	☐	☐	☐	☐	60.	☐	☐	☐	☐	98.	☐	☐	☐	☐
23.	☐	☐	☐	☐	61.	☐	☐	☐	☐	99.	☐	☐	☐	☐
24.	☐	☐	☐	☐	62.	☐	☐	☐	☐	100.	☐	☐	☐	☐
25.	☐	☐	☐	☐	63.	☐	☐	☐	☐					
26.	☐	☐	☐	☐	64.	☐	☐	☐	☐					
27.	☐	☐	☐	☐	65.	☐	☐	☐	☐					
28.	☐	☐	☐	☐	66.	☐	☐	☐	☐					
29.	☐	☐	☐	☐	67.	☐	☐	☐	☐					
30.	☐	☐	☐	☐	68.	☐	☐	☐	☐					
31.	☐	☐	☐	☐	69.	☐	☐	☐	☐					
32.	☐	☐	☐	☐	70.	☐	☐	☐	☐					
33.	☐	☐	☐	☐	71.	☐	☐	☐	☐					
34.	☐	☐	☐	☐	72.	☐	☐	☐	☐					
35.	☐	☐	☐	☐	73.	☐	☐	☐	☐					
36.	☐	☐	☐	☐	74.	☐	☐	☐	☐					
37.	☐	☐	☐	☐	75.	☐	☐	☐	☐					
38.	☐	☐	☐	☐	76.	☐	☐	☐	☐					

Complete Answer Sheet for Science Laboratory Safety Test

Name ______ Period ______ Test No. ______ Score ______

Directions: Read each statement in your safety test. Under each question you will find four answers. Choose the one correct answer and fill in the box that represents the answer.

Example: Read question 1. The correct answer is "b. at once." Note that the "b" box beside number 1 (see example below) is darkened. Continue marking all the answers in this manner.

	a	b	c	d	39.	■	☐	☐	☐	77.	☐	☐	☐	☐
1.	☐	■	☐	☐	40.	☐	☐	☐	☐	78.	☐	☐	☐	☐
2.	☐	■	☐	☐	41.	☐	☐	☐	☐	79.	☐	☐	☐	☐
3	■	☐	☐	☐	42.	☐	☐	☐	☐	80.	☐	☐	☐	☐
4.	☐	■	☐	☐	43.	☐	☐	☐	☐	81.	☐	☐	☐	☐
5.	☐	☐	■	☐	44.	☐	☐	☐	☐	82.	☐	☐	☐	☐
6.	☐	■	☐	☐	45.	☐	☐	☐	☐	83.	☐	☐	☐	☐
7.	☐	■	☐	☐	46.	☐	☐	☐	☐	84.	☐	☐	☐	☐
8.	☐	■	☐	☐	47.	☐	☐	☐	☐	85.	☐	☐	☐	☐
9.	☐	■	☐	☐	48.	☐	☐	☐	☐	86.	☐	☐	☐	☐
10.	☐	☐	■	☐	49.	☐	☐	☐	☐	87.	☐	☐	☐	☐
11.	☐	■	☐	☐	50.	☐	☐	☐	☐	88.	☐	☐	☐	☐
12.	☐	☐	☐	■	51.	☐	☐	☐	☐	89.	☐	☐	☐	☐
13.	■	☐	☐	☐	52.	☐	☐	☐	☐	90.	☐	☐	☐	☐
14.	☐	■	☐	☐	53.	☐	☐	☐	☐	91.	☐	☐	☐	☐
15.	☐	☐	■	☐	54.	☐	☐	☐	☐	92.	☐	☐	☐	☐
16.	☐	☐	☐	■	55.	☐	☐	☐	☐	93.	☐	☐	☐	☐
17.	☐	■	☐	☐	56.	☐	☐	☐	☐	94.	☐	☐	☐	☐
18.	☐	■	☐	☐	57.	☐	☐	☐	☐	95.	☐	☐	☐	☐
19.	■	☐	☐	☐	58.	☐	☐	☐	☐	96.	☐	☐	☐	☐
20.	☐	☐	☐	■	59.	☐	☐	☐	☐	97.	☐	☐	☐	☐
21.	☐	☐	■	☐	60.	☐	☐	☐	☐	98.	☐	☐	☐	☐
22.	■	☐	☐	☐	61.	☐	☐	☐	☐	99.	☐	☐	☐	☐
23.	☐	☐	☐	■	62.	☐	☐	☐	☐	100.	☐	☐	☐	☐
24.	■	☐	☐	☐	63.	☐	☐	☐	☐					
25.	☐	■	☐	☐	64.	☐	☐	☐	☐					
26.	■	☐	☐	☐	65.	☐	☐	☐	☐					
27.	☐	☐	☐	■	66.	☐	☐	☐	☐					
28.	■	☐	☐	☐	67.	☐	☐	☐	☐					
29.	☐	☐	■	☐	68.	☐	☐	☐	☐					
30.	☐	☐	☐	■	69.	☐	☐	☐	☐					
31.	☐	☐	☐	■	70.	☐	☐	☐	☐					
32.	☐	☐	☐	■	71.	☐	☐	☐	☐					
33.	☐	☐	■	☐	72.	☐	☐	☐	☐					
34.	☐	☐	■	☐	73.	☐	☐	☐	☐					
35.	☐	☐	■	☐	74.	☐	☐	☐	☐					
36.	☐	■	☐	☐	75.	☐	☐	☐	☐					
37.	☐	■	☐	☐	76.	☐	☐	☐	☐					
38.	☐	☐	☐	■										

APPENDIX H

SAMPLE

SAFETY CHECKLIST FOR SCIENCE INSTRUCTION, PREPARATION, AND STORAGE AREAS

School: ______________________ Date: ______________________

Teacher(s): ______________________ Room or area: ______________________

Science teachers should check their instructional areas periodically to determine whether unsafe conditions exist. Teachers who have concerns about safety conditions related to facilities, equipment, supplies, curriculum, classroom occupant load, and so on should notify their department chairpersons and school-site administrators immediately in writing for assistance in alleviating the condition.

The following checklist may be used to determine whether or not a safe environment exists and to indicate possible areas of concern and danger (see also appendixes B and C in *Science Facilities Design for California Public Schools*, published by the California Department of Education in 1993):

1. Good general housekeeping prevails, and aisles are clear of materials and apparatus. ☐
2. Signs of the locations of first-aid and safety equipment are visible throughout the room (e.g., fire extinguishers, fire blanket, eyewash station). ☐
3. Adequate storage space is provided for chemicals, materials, and apparatus. ☐
4. The classroom/laboratory has no blind spots; that is, areas in which students cannot be supervised by the teacher from anywhere in the room. ☐
5. There is adequate classroom/laboratory space for the various learning activities planned. ☐
6. The following equipment or conditions are adequate:
   - Counter and work space for all students to do laboratory activities at one time ☐
   - Electrical outlets ☐
   - Gas outlets ☐
   - Sinks and water faucets ☐
   - Space between laboratory stations ☐
   - Ventilation for the laboratory activities planned (or a manually controlled purge system for the rapid exchange of room air) ☐
7. There are ground fault circuit interrupters (GFCIs) on electrical outlets near sinks. ☐
8. Cabinets and open shelves are equipped with lips or restraining wires to prevent spilling of chemicals or broken glassware during an explosion or earthquake. ☐
9. The room has at least two exits. ☐
10. The light level is adequate (about 75 to 100 foot-candles at work surfaces). ☐
11. Separate designated waste containers are provided for:
    - Broken glass ☐
    - Spent matches, wood splints, toothpicks, and so on ☐
    - Flammable waste chemicals ☐
    - Nonflammable waste chemicals ☐

12. Quantities of hazardous chemicals kept on hand are limited to the amounts needed during one school year. ☐

13. Proper labels and signs are kept in place on all chemicals and on the storage area. ☐

14. A chemical-spill kit is available for emergency use. ☐

15. Chemical containers are inspected periodically for leakage or deterioration (such as sediments and discoloration), and approved disposal procedures are followed as necessary. ☐

16. Any cylinder gas is stored according to the required safety code (for example, chained or strapped in a cart or to the wall). ☐

17. Splash-proof safety goggles, face shields, aprons, safety shields, and so on are available to protect the teacher and students when hazardous conditions exist. ☐

18. Goggles and face-shield sterilization facilities are available. ☐

19. Eyewash fountains, hand-held drench hoses, and safety showers (as necessary) are easily accessible and are flushed weekly to remove scale and rust. ☐

20. Fume hoods are clean, are uncluttered, and have a streamer easily visible throughout the room when in operation; the hoods are tested periodically to ensure adequate air flow. ☐

21. All equipment is properly maintained. ☐

22. All electrical equipment is three-wire grounded except for double-insulated tools and equipment. ☐

23. Electrical outlets and extension cords are kept in safe working condition. ☐

24. Electrical equipment, such as the refrigerator and aquarium aerator, is connected directly to a wall outlet and is not serviced through an extension cord. ☐

25. Gas outlets and burners are maintained in safe working condition. ☐

26. A fire extinguisher capable of extinguishing class A, B, and C fires is kept in working condition at all times and in a conspicuous and accessible place. ☐

27. Dry sand or other appropriate means is available to extinguish class D fires. ☐

28. An approved fire blanket (preferably fire-retardant-treated 100 percent wool) is kept in a conspicuous and accessible place. ☐

29. Flammable liquids are held in the classroom in fireproof containers (not glass) and in quantities sufficient only for one day's supply. ☐

30. Approved fire-retardant storage cabinets (with a bottom pan to contain spills temporarily), separate from the classroom, are used for storing larger quantities of flammable, corrosive, and other dangerous chemicals. ☐

31. The larger storage containers of acids and bases are stored on the lower cabinet shelves. ☐

32. Flammable liquids are not kept in refrigerators, unless the refrigerator is certified as explosion-proof. ☐

33. Food is not kept in refrigerators used for storing science materials. ☐

34. Ether on hand was purchased less than one year ago. ☐

35. Ethers are periodically disposed of before they exceed their one-year shelf life. (See "Use and Disposal of Ethers" in Chapter 5 of this handbook.) ☐

36. Sodium is stored under kerosene or oil. ☐

37. Incompatible chemicals are not stored adjacent to one another. (See page 42 for a list of chemical storage compatibility categories for chemicals found in high school laboratories.) ☐

38. All chemical containers are dated on receipt, and a current inventory is maintained. ☐

39. The material safety data sheet (MSDS) is readily available for any chemical being handled or used in school. ☐

40. The locations of the master electrical and gas shut-off controls are labeled and readily accessible. ☐

41. Plumbing fixtures are in correct operating condition. Faucets are equipped with air gaps to prevent backflow. ☐

42. Animals are cared for in an appropriate, safe, and humane environment. ☐

43. Hazardous chemical waste is properly stored, handled, and disposed of. ☐

44. Fire-drill and earthquake-drill procedures are posted and familiar to all teachers and students. ☐

45. The school district's emergency procedures are prominently posted. ☐

46. An adequate first-aid kit, including the Red Cross *Standard First Aid and Personal Safety Manual* or appropriate alternate information, is provided. (See Chapter 2, "First Aid," in this handbook.) ☐

47. The teacher is familiar with first-aid and safety measures related to science instruction as presented in this publication. ☐

48. The *Science Safety Handbook for California Public Schools* is readily accessible. ☐

Write a summary of the survey and note actions taken to remedy inadequate conditions.

Signature(s). ______________________ Date ______________

______________________ Date ______________

______________________ Date ______________

APPENDIX I

END-OF-YEAR SAFETY AND ENERGY-SAVINGS PROCEDURES

1. Inventory all chemicals. Remove all outdated, deteriorated, potentially dangerous, and not-likely-to-be-used substances. Pack them in separate boxes by compatibility category and clearly mark the boxes *Chemicals for disposal.* Attach a list of contents to each box. Call the appropriate school district office or waste disposal agency to pick up the materials; identify the *exact location* of the items to be picked up.
2. Dispose of diethyl ether older than one year and ethers in containers that are partially used; follow the procedure outlined in Chapter 5, section I. (Any ether may form peroxides, as described in the section just cited.) Only recently received, unopened containers of ethers that were dated on receipt and can be verified as less than one year old by the time of their use in fall laboratory activities may be retained and should be locked in the school district's standard flammable-liquids cabinet during the summer break. Refer to the safety checklist in Appendix H, items 15, 34, and 35.

   Recommendation: Order only those supplies of ether necessary for the current school year.
3. Be certain all gas cylinders in high school laboratories are capped and properly secured for the summer.
4. Clean out, defrost, and leave unplugged all refrigerators during the summer break. Block the doors open to allow air circulation and prevent growth of mildew. This recommendation is for both safety and energy conservation.
5. Arrange for shutoff of any water heaters in the science department.
6. Unplug all electrical items, such as isolated wall clocks, timers, personal table clocks/radios, hotplates, aquarium pumps, computers, terminals, microscope lights, oscilloscopes, and any other electrically powered science instructional item.
7. Arrange for adequate temperature control and ventilation of sensitive equipment and chemicals to ensure their safe storage.

APPENDIX J

SAMPLE

BIOLOGICAL SCIENCE LABORATORY REGULATIONS

______________________ School District

The following regulations have been compiled for the safety of students performing laboratory work in biological science classes. Strict observance of the regulations is mandatory. All students in the school district are to follow these regulations, rather than any conflicting instructions in textbooks or laboratory manuals.

Students and parents are to read the regulations, sign the form, and return the form to the instructor. This procedure must be completed before a student can begin any laboratory activity. The student should keep a copy of the regulations in his or her notebook for future reference.

General

1. An instructor must be present during the performance of all laboratory work.
2. Prepare for each laboratory activity by reading all instructions before coming to class. Follow all directions implicitly and intelligently. Make a note of any modification in procedure given by the instructor.
3. Always approach laboratory experiences in a serious and courteous manner.
4. Use only those materials and equipment authorized by the instructor. Any science project or individually planned experiment must be approved by the teacher.
5. Know the proper fire- and earthquake-drill procedures.
6. Roll long sleeves above the wrist. Long, hanging necklaces, bulky jewelry, and excessive and bulky clothing should not be worn in the laboratory.
7. Confine long hair during a laboratory activity.
8. Wear shoes that cover the toes, rather than sandals, in the laboratory.
9. Wear appropriate eye protection, as directed by the instructor, whenever you are working in the laboratory. Safety goggles must be worn during hazardous activities involving caustic/corrosive chemicals, heating of liquids, and other activities that may injure the eyes.
10. Splashes and fumes from hazardous chemicals present a special danger to wearers of contact lenses. Therefore, students should preferably wear regular glasses (inside splash-proof goggles, when appropriate) during all class activities or purchase personal splash-proof goggles and wear them whenever exposure to chemicals or chemical fumes is possible.
11. Place books, purses, and other such items in the designated storage area. Take only laboratory manuals and notebooks into the working area.
12. Report any accident to the teacher immediately, no matter how minor. Included are reports on any burn, scratch, cut, or corrosive liquid on skin or clothing.
13. Students with open skin wounds on hands must wear gloves or be excused from the laboratory activity.
14. Eating or drinking in the laboratory or from laboratory equipment is not permitted.
15. Students are not permitted in laboratory storage rooms or teachers' workrooms without the approval of the teacher.

Handling Equipment

16. Inform the teacher immediately of any equipment not working properly.
17. Report broken glassware, including thermometers, to the instructor immediately.
18. Operate electrical equipment only in a dry area and with dry hands.
19. When removing an electrical plug from its socket, pull the plug, not the electrical cord.
20. When heating material in a test tube, do not look into the mouth of the tube or point it in the direction of any person during the process.
21. When heating volatile or flammable materials, use a water bath; that is, heat the materials in or over heated water, using a hot plate to heat the water. Extinguish all open flames.
22. Know the location and operation of the emergency shower, eyewash and facewash fountain, fire blanket, fire extinguisher, fire alarm box, and exits.
23. Light gas burners only as instructed by the teacher. Be sure no volatile materials (such as alcohol or acetone) are being used nearby.
24. Use a burner with extreme caution. Keep your head and clothing away from the flame and turn it off when not in use.
25. Use a fire blanket to extinguish any flame on a person (see "stop, drop, and roll" procedure in Chapter 2, section C).
26. Use the fume hood whenever noxious, corrosive, or toxic fumes are produced or released.

27. Exercise caution in using scissors, scalpels, dissecting needles, and other sharp-edged instruments. Pass them with handles extended when handing them to other persons.
28. Wash all sharp-edged and pointed instruments separately from other equipment.
29. Match hole size and tubing when inserting glass tubing into a stopper. If necessary, expand the hole first by using an appropriate size cork borer. Lubricate the stopper hole and glass tubing with water or glycerin to ease insertion, using towels to protect the hand. Carefully twist (never push) glass tubing into stopper holes.

Handling Chemicals

30. Check labels and equipment instructions carefully. Be sure correct items are used in the proper manner.
31. Be aware if the chemicals being used are hazardous. Know where the material safety data sheet (MSDS) is and what it indicates for each of the hazardous chemicals you are using.
32. Never pour reagents back into bottles, exchange stoppers of bottles, or lay stoppers on the table.
33. Use great care when working with ether or other volatile liquids. Windows and doors should be opened for greatest possible ventilation. Be sure that caps or lids of containers used for chemicals are securely closed.
34. Keep hands away from face, eyes, and clothes while using solutions, specimens, equipment, or materials in the laboratory.
35. To treat a burn from an acid or alkali, wash the affected area immediately with plenty of running water. If the eye is involved, irrigate it at the eyewash station without interruption for 15 minutes. Report the incident to your instructor immediately.
36. Never carry hot equipment or dangerous chemicals through a group of students.
37. Use a mechanical pipette filler (never the mouth) when measuring or transferring small quantities of liquid with a pipette.
38. Never taste anything or touch chemicals with the hands unless specifically instructed to do so.

Plants and Animals

39. Rinse dissection specimens occasionally or whenever fumes or chemicals are released in the dissection process.
40. Never handle animals in the laboratory unless directed to do so by the instructor.
41. Never insert your fingers or objects through the wire mesh of animal cages to pet or tease the animals.
42. Notify the instructor at once if an animal bites you.
43. Never bring animals or poisonous plants to school.

Bacteria and Fungi

44. Never open petri dishes containing bacterial or fungal growth unless directed to do so by the instructor.
45. Dispose of all discarded bacterial and fungal cultures by sterilization as directed by the instructor.

Cleanup and Disposal

46. Be sure all glassware is clean before use. Clean glassware thoroughly after use. Residue may cause errors in new experiments or cause a violent reaction or explosion.
47. Keep work areas clean. Floors and aisles should be kept clear of equipment and materials.
48. Clean up any spill on the floor or work space immediately.
49. Dispose of laboratory waste as instructed by the teacher. Use separate designated containers (not the wastebasket) for the following:
    - Matches, litmus paper, wooden splints, toothpicks, and so on
    - Broken and waste glass
    - Rags, paper towels, or other absorbent materials used in the cleanup of flammable solids or liquids
    - Hazardous/toxic liquids and solids
50. Remove all broken glass from the work area or floor as soon as possible. Never handle broken glass with bare hands; use a counter brush and dustpan.
51. Always clean the laboratory area before leaving.
52. Students and teacher wash hands with soap and water before leaving the laboratory area.

Note: Persistent or willful violation of the regulations will result in the loss of laboratory privileges and possible dismissal from the class.

Please see the "Student Safety Contract—Biological Science" on the following page.

Student Safety Contract—Biological Science

School: ______________________ Teacher: ______________________________ Date: __________

Student's name: ______________________________________

The student has received specific instruction regarding the use, function, and location of the following:

- Aprons, gloves ☐
- Chemical-spill kit ☐
- Eye-protective devices (goggles, face shield, safety shield) ☐
- Eyewash fountain, drench spray, and drench shower ☐
- Fire extinguisher ☐
- Fire blanket ☐
- First-aid kit ☐
- Heat sources (burners, hot plate, microwave) and techniques in their use ☐
- Material safety data sheets (MSDSs) ☐
- Waste-disposal containers for glass, chemicals, matches, paper, wood ☐

The student will abide by the "Biological Science Laboratory Regulations" to prevent accidents and injury to herself or himself and others and will:

- Follow all additional instructions given by the teacher.
- Conduct herself or himself in a responsible manner at all times in the laboratory.

List below any special allergies or sensitivities (e.g., to plants, animals, pollen, foods, chemicals, bee stings) that may affect the student's safety in the laboratory or on field trips:

____

Check this box if the student wears contact lenses: ☐

Student's Statement

I have in my possession and have read the "Biological Science Laboratory Regulations" (pages 155–56) and agree to abide by them at all times while in the laboratory. I have received specific safety instruction as indicated above.

______________________________________ ______________

Signature of student Date

Parent's or Guardian's Statement

I have read the "Biological Science Laboratory Regulations" (pages 155–56) and give my consent for the student who has signed the preceding statement to engage in laboratory activities using a variety of science equipment and materials, including those described. I pledge my cooperation in urging that she or he observe the safety regulations prescribed.

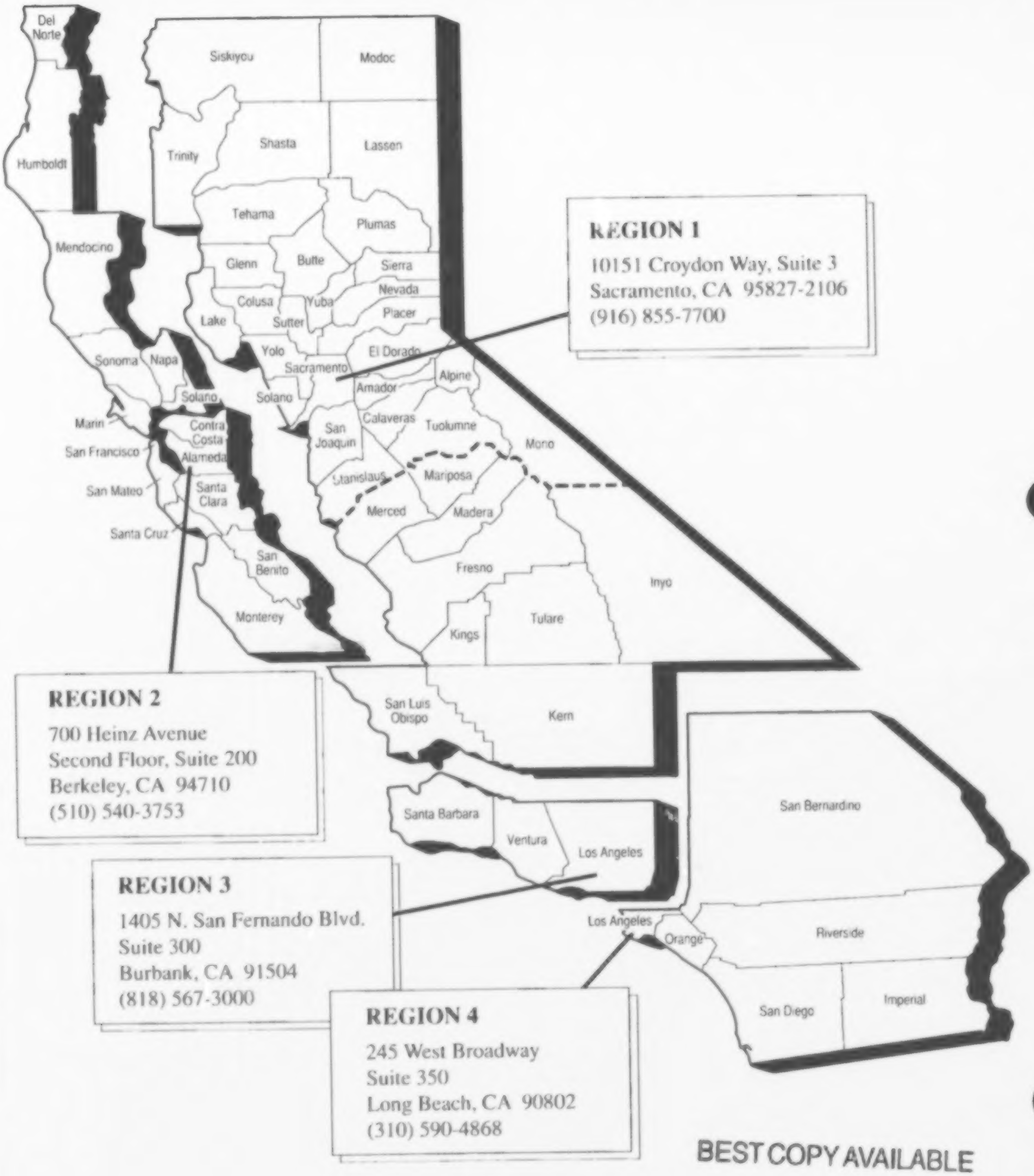
______________________________________ ______________

Signature of parent or guardian Date

Return the completed and signed form to ______________________ *by* ______________.

APPENDIX K

TOXIC SUBSTANCES CONTROL REGIONAL OFFICES


Del Norte
Siskiyou
Modoc
Humboldt
Trinity
Shasta
Lassen
Tehama
Plumas
Mendocino
Glenn
Butte
Sierra
Nevada
Colusa
Yuba
Lake
Sutter
Placer
Yolo
El Dorado
Sonoma
Napa
Sacramento
Solano
Solano
Amador
Alpine
Marin
Contra Costa
San Joaquin
Calaveras
Tuolumne
Mono
San Francisco
Alameda
Stanislaus
Mariposa
San Mateo
Santa Clara
Merced
Madera
Santa Cruz
San Benito
Fresno
Inyo
Monterey
Kings
Tulare
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Los Angeles
Orange
Riverside
San Diego
Imperial

REGION 1

10151 Croydon Way, Suite 3
Sacramento, CA 95827-2106
(916) 855-7700

REGION 2

700 Heinz Avenue
Second Floor, Suite 200
Berkeley, CA 94710
(510) 540-3753

REGION 3

1405 N. San Fernando Blvd.
Suite 300
Burbank, CA 91504
(818) 567-3000

REGION 4

245 West Broadway
Suite 350
Long Beach, CA 90802
(310) 590-4868

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APPENDIX L

SCIENCE LABORATORY SAFETY/LIABILITY CHECKLIST

The safety program in the school and school district should be dedicated to preventing and minimizing injury to personnel, limiting the liability of schools and school districts and their personnel, and protecting and preserving the facilities and the environment.

The following checklist represents some of the main considerations that schools, school districts, and individuals should address in planning and implementing their science laboratory safety program.

1. The school or the school district must have a written plan (if the plan is for the school district, it should be written to include the schools involved) for, or exemption from, each of the following:
   - Chemical hygiene plan (CHP), *California Code of Regulations, Title 8,* Section 5191 (required of all employers in workplaces in which there is laboratory use of hazardous chemicals; the CHP is to include safe operating procedures, use of protective equipment, employee information and training, provisions for medical consultations and examinations, and designation of a chemical hygiene officer) ☐
   - Bloodborne pathogens exposure control plan, *California Code of Regulations, Title 8,* Section 5193 (required of all *employers* with employees reasonably anticipated to have exposure to blood or other potentially infectious materials in the performance of their duties) ☐
   - Hazard communication; material safety data sheet (MSDS), *California Code of Regulations, Title 8,* Section 5194 (may be included in chemical hygiene plan noted above [see also Chapter 5, section E]; required of all employers in workplaces in which hazardous chemicals are used unless all exposed employees are under the direct supervision and regular observation of an individual with knowledge of physical and health hazards and emergency procedures and who conveys this knowledge to employees in terms of safe work practices. Labels and MSDSs received must be maintained and available to employees) ☐
2. The school or school district has implemented a plan for the safe storage, use, and disposal of hazardous chemicals (*Education Code* Section 49411). ☐
3. The implementation of the overall safety plan makes provisions at all levels for instruction and training, responsible supervision, and adequate and well-maintained facilities and equipment. ☐
4. Safety equipment includes each of the following, as appropriate:
   - Fire extinguisher for classes A, B, and C fires ☐
   - Dry sand or other provision for class D fires ☐
   - Fire blanket ☐
   - Splash-proof goggles and sterilizer ☐
   - Eyewash or eyewash and facewash fountain; drench hose ☐
   - Deluge shower ☐
   - Chemical-spill kit ☐
   - Fume hood ☐
   - First-aid kit ☐
5. Teachers are prepared to safely handle, use, and store science supplies and equipment as well as safety equipment. Documentation of staff training should be maintained on both school and school district sites. ☐
6. A safety assessment is regularly made of the science classrooms/laboratories and auxiliary rooms (e.g., by using the "Safety Checklist for Science Instruction, Preparation, and Storage Areas," found in Appendix H) ☐
7. Each science teacher consciously includes safety as a component in planning and conducting each lesson, demonstration, and activity. ☐
8. Classrooms are inspected daily for irregularities or dangerous conditions, including, but not limited to, faulty equipment, improper ventilation, and missing or nonfunctional safety supplies. ☐
9. Potential dangers (safety hazards, defective equipment, or unsafe conditions) that cannot be readily corrected within the department are reported immediately to the site administrator for necessary action. ☐

10. Each class is provided with proper initial instruction in safety procedures, specific to the subject, which are reviewed regularly. The review includes the following:
    - Use of safety equipment, devices, and materials ☐
    - Proper laboratory preparation, attire, and attitude ☐
    - Proper use of material and equipment ☐
    - Disposal and clean-up procedures ☐
11. Documentation files are maintained on the types of instruction given and the dates on which safety-related topics were demonstrated, conducted, or tested. ☐
12. Student safety consent/contract forms, which attest to initial safety instruction and a knowledge of laboratory regulations and potential dangers, are signed by the student and a parent or guardian and retained by the teacher. ☐
13. The school and school district fire and earthquake drills and emergency procedures include special provisions relating to science equipment, facilities, and materials. Procedures are included for contacting community resources (fire department, ambulance, paramedics, hospital, doctor). ☐
14. A report is made of any injury, illness, or incident, including appropriate procedures for remediation. ☐
15. Safety guidelines adopted by the school and school district are reviewed and updated on a regular basis. ☐

By following the suggestions noted above, instructors, schools, school districts, and students can improve their ability to conduct laboratory activities safely and effectively. Failure to implement the procedures increases the relative degree of liability of school districts and individuals.

APPENDIX M

Sample Chemical Inventory

School | Room | Date

Inventory prepared by

Date acquired	*Chemical name*	*Concentration /Purity*	*Type of container*	*Quantity*	*Hazard class*	*Storage location*	*Storage compatibility*	*Shelf life*	*MSDS available*	*Notes*
8-94	Acetic acid	1.0	Glass	1 liter						
2-94	Acetone	99.5%	Metal can	400 ml						

APPENDIX N

DEPARTMENT OF TRANSPORTATION HAZARD CLASSES

The U.S. Department of Transportation (DOT) has completed a list of materials that are designated as hazardous for the purpose of transportation of those materials in commerce. The list, labeled "Hazardous Materials Table" in the *Code of Federal Regulations, Title 49*, Transportation, specifies for each listed material a *hazard class* (or division within the class) that affects the required packaging, mailing, and labeling of the material. The hazard class specification is important to anyone who will be shipping those materials either for initial use or for disposal.

In this publication the hazard class/division for each chemical listed in Table 3, "Hazardous Chemicals Reference Table," is noted in the column titled *Label*. The hazard groups include explosives, combustible liquids, compressed gases, corrosives, flammable gases, flammable liquids, flammable solids, and poisons. Excerpts from the *Code of Federal Regulations, Title 49*, Chapter 1 (October 1, 1993, edition), defining those groups are as follows:

173.50. Class 1—Definitions

(a) *Explosive*. . . . An *explosive* means any substance or article, including a device, which is designed to function by explosion (i.e., an extremely rapid release of gas and heat) or which, by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion. . . .

(b) Explosives in Class 1 are divided into six divisions as follows:

(1) Division 1.1 consists of explosives that have a mass explosion hazard. A mass explosion is one which affects almost the entire load instantaneously.

(2) Division 1.2 consists of explosives that have a projection hazard but not a mass explosion hazard.

(3) Division 1.3 consists of explosives that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.

(4) Division 1.4 consists of explosives that present a minor explosion hazard. The explosive effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package.

(5) Division 1.5 consists of very insensitive explosives. This division is comprised of substances which have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of transport.

(6) Division 1.6 consists of extremely insensitive articles which do not have a mass explosive hazard. This division is comprised of articles which contain only extremely insensitive detonating substances and which demonstrate a negligible probability of accidental initiation or propagation. . . .

173.115. Class 2, Divisions 2.1, 2.2, and 2.3—Definitions

(a) Division 2.1 *(Flammable Gas)* . . . means any material which is a gas at 20°C (68°F) or less and 101.3 kPa (14.7 psi) of pressure (a material which has a boiling point of 20°C [68°F] or less at 101.3 kPa [14.7 psi]) which:

(1) Is ignitable at 101.3 kPa (14.7 psi) when in a mixture of 13 percent by volume with air; or

(2) Has a flammable range at 101.3 kPa (14.7 psi) with air of at least 12 percent regardless of the lower limit. . . .

(b) Division 2.2 *(Nonflammable, Nonpoisonous Compressed Gas—including compressed gas, liquefied gas, pressurized cryogenic gas, and compressed gas in solution)* . . . means any material (or mixture) which—

(1) Exerts in the packaging an absolute pressure of 280 kPa (41 psi) at 20°C (68°F), and

(2) Does not meet the definition of Division 2.1 or 2.3.

(c) Division 2.3 *(Gas poisonous by inhalation)* . . .

173.120. Class 3—Definitions

(a) *Flammable liquid* . . . means a liquid having a flash point of not more than 60.5°C (141°F), or any material in a liquid phase with a flash point at or above 37.8°C (100°F).

(b)(1). . . a *combustible liquid* means any liquid that does not meet the definition of any other hazard class specified in this subchapter and has a flash point above 60.5°C (141°F) but below 93°C (200°F). . . .

(2) A flammable liquid with a flash point at or above 38°C (100°F) that does not meet the definition of any other hazard class . . .

(c) *Flash point*. (1) Flash point means the minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. . . .

173.124. Class 4, Divisions 4.1, 4.2, and 4.3—Definitions

(a) Division 4.1 (*Flammable Solid*) . . . means any of the following three types of materials:

(1) Wetted explosives that—

(i) When dry are explosives of Class 1 other than those of compatibility group A which are wetted with sufficient water, alcohol, or plasticizer to suppress explosive properties; and

(ii) Are specifically authorized by name either in the section 172.101 table or have been assigned a shipping name and hazard class by the Associate Administrator for Hazardous Materials Safety under the provisions of—

(A) An exemption issued under subchapter A of this chapter; or

(B) An approval issued under section 173.56(i) of this part.

(2) Self-reactive materials are liable to undergo, at normal or elevated temperatures, a strongly exothermal decomposition caused by excessively high transport temperatures or by contamination; and

(3) Readily combustible solids are materials that—

(i) Are solids which may cause a fire through friction, such as matches;

(ii) Show a burning rate faster than 2.2 mm (0.087 inches) per second when tested in accordance with paragraph 2.c.(2) of appendix E to this part; or

(iii) Are metal powders that can be ignited and react over the whole length of a sample in 10 minutes or less, when tested in accordance with paragraph 2.c.(2) of appendix E to this part.

(b) Division 4.2 *(Spontaneously combustible material)* . . .

(c) Division 4.3 *(Dangerous when wet material)* . . . means a material that, by contact with water, is liable to become spontaneously flammable or to give off flammable or toxic gas at a rate greater than 1 liter per kilogram of the material per hour . . .

173.127. Class 5, Division 5.1 and 5.2—Definitions

. . . *Oxidizer* (Division 5.1) means a material that may, generally by yielding oxygen, cause or enhance the combustion of other materials. . . .

Division 5.2 . . . *Organic peroxide* . . .

173.132. Class 6, Division 6.1—Definitions

. . . *poisonous material* . . . means a material, other than a gas, which is known to be so toxic to humans as to afford a hazard to health during transportation, or which, in the absence of adequate data on human toxicity:

(1) Is presumed to be toxic to humans because it falls within any one of the following categories when tested on laboratory animals (whenever possible, animal test data that has been reported in the chemical literature should be used):

(i) Oral Toxicity. A liquid with an LD50 for acute oral toxicity of not more than 500 mg/kg or a solid with an LD50 for acute oral toxicity of not more than 200 mg/kg.

(ii) Dermal Toxicity. A material with an LD50 for acute dermal toxicity of not more than 1000 mg/kg.

(iii) Inhalation Toxicity. (A) A dust or mist with an LC50 for acute toxicity on inhalation of not more than 10 mg/L; or (B) a material with a saturated vapor concentration in air at 20°C (68°F) of more than one-fifth of the LC50 for acute toxicity on inhalation of vapors of not more than 5000 ml/m3; or

(2) Is an irritating material, with properties similar to tear gas, which causes extreme irritation, especially in confined spaces. . . .

Division 6.2 . . . *infectious substance* . . . means a viable microorganism, or its toxin, which causes or may cause disease in humans or animals. . . .

173.401–173.48. Class 7 *Radioactive*

173.136. Class 8

. . . *corrosive material* (Class 8) means a liquid or solid that causes visible destruction or irreversible alterations in human skin tissue at the site of contact, or a liquid that has a severe corrosion rate on steel or aluminum. . . .

173.140. Class 9

. . . *miscellaneous hazardous material* (Class 9) means a material which presents a hazard during transportation but which does not meet the definition of any other hazard class. . . .

173.144.

. . . "ORM-D material" means a material, such as a consumer commodity, which, although otherwise subject to the regulations of this subchapter, presents a limited hazard during transportation due to its form, quantity, and packaging. . . .

APPENDIX O

CARCINOGEN "REPORT OF USE" FORM

The form on the following page (along with the accompanying questionnaire) should be completed by any school that uses or has in storage any carcinogen included in the list shown on the form. Butadiene, 5201, is added to the form effective August 27, 1997.

This is a nonmandatory form developed by Cal/OSHA to assist the regulated public in complying with the several regulations for which a "Report of Use" is required. Other means of providing the information required in the individual regulation that requires report of use is acceptable.

A copy of each report required should also be posted in a conspicuous place in the area in which the carcinogen(s) is used.

STATE OF CALIFORNIA

Pete Wilson, Governo

DEPARTMENT OF INDUSTRIAL RELATIONS
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
OCCUPATIONAL CARCINOGEN CONTROL UNIT
45 Fremont Street, 11th Floor
San Francisco, CA 94105

ADDRESS REPLY TO:
P.O. BOX 420603
San Francisco, CA 94142

Report of Use Number:____________
Original Report Date:____________
Date of Change:____________

Dear Employer/Company:

California Code of Regulations, Title 8 standards require submitting a Report of Use regarding regulated carcinogens to Chief, Division of Occupational Safety and Health. The list below indicates those carcinogens currently regulated and references the appropriate standard's sections. Completion of the information below meets the requirements of the Report of Use.

Any change in location, use, additions, or deletions of carcinogens used in your workplace, shall be sent **within 15 calendar days. Exceptions: (10 days for carcinogens in Sections 5212, 5219, 5220).**

A copy of each written report required by the section shall be posted in the locations where the carcinogen(s) is/are present in the workplace or in other appropriate location(s) where the posting is conspicuous to affected employees.

REPORT OF USE OF REGULATED CARCINOGENS

____ 2-Acetylaminofluorene, 5209
____ 4-Aminodiphenyl
____ Benzidine (and its salts)
____ 3,3'-Dichlorobenzidine (and its salts)
____ 4-Dimethylaminoazobenzene
____ alpha-Naphthylamine
____ beta-Naphthylamine
____ 4-Nitrobiphenyl
____ N-Nitrosodimethylamine
____ beta-Propiolactone
____ bis-Chloromethyl ether
____ Methyl chloromethyl ether
____ Ethyleneimine

____ Methylenedianiline (MDA), 1535, 5200
____ Cadmium, 1532, 5207
____ Asbestos, 1529, 5208, 5208.1, 8358
____ Vinyl Chloride, 5210
____ Coke Oven Emissions, 5211
____ 1,2-Dibromo-3-Chloropropane (DBCP), 5212
____ Acrylonitrile, 5213
____ Inorganic Arsenic, 5214
____ 4,4'-Methylenebis(2-Chloroaniline) (MBOCA), 5215
____ Formaldehyde, 5217
____ Benzene, 5218
____ Ethylene Dibromide (EDB), 5219
____ Ethylene Oxide (Et0), 5220

______________________________ __________( )__________
Employer/Company and Division name   Telephone number

____
Address: Number and Street   City   County   Zip

____
(If there has been a change, write the **previous** name; address; report number)

____
Original signature and title of responsible representative   Date   (Legibily print name please)

Continued on reverse side

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1. Provide the name(s) of each carcinogen and a brief description of the way in which the regulated carcinogen(s) or carcinogen-containing product(s) is/are manufactured, processed, handled, used, stored, repackaged or transported.

2. The name and address of each workplace; in-plant location, in which the carcinogen(s) is/are present in accordance with that carcinogen's subsection.

3. A brief description of each process or operation which may result in employee(s) exposure to the carcinogen(s).
   a. Include, the number of employees engaged in each process or operation.
   b. Estimate the frequency and level of exposure to the employee(s) during each process or operation.

4. The name and address of any collective bargaining representative(s), or other representatives of the affected employees.

5. For carcinogen(s) listed under the sections that you are reporting as used, please refer to the regulations regarding the quantity of the carcinogen used and the frequency of employee exposure.

6. **Nature of Business:** Indicate the industry and principal product(s). Examples: agriculture pesticides; construction, manufacturing, mining, transportation, services, etc., as assigned in the Standard Industrial Classification Manual

If you have questions regarding the sections cited, please call the **Occupational Carcinogen Control Unit at (415) 972-8577.**

APPENDIX P

SAMPLE

PHYSICAL SCIENCE LABORATORY REGULATIONS

________________ School District

The following regulations have been compiled for the safety of students performing experimental work in physical science classes. Strict observance of the regulations is mandatory. All students in the school district are to follow these regulations, rather than any conflicting instructions in textbooks or laboratory manuals.

Students and parents are to read the regulations, sign the form, and return the form to the instructor. This procedure must be completed before a student can begin any laboratory activity. The student should keep a copy of the regulations in his or her notebook for future reference.

General

1. An instructor must be present during the performance of all laboratory work.
2. Prepare for each laboratory activity by reading all instructions before coming to class. Follow all directions implicitly and intelligently. Make a note of any modification in procedure given by the instructor.
3. Always approach laboratory experiences in a serious and courteous manner.
4. Use only those materials and equipment authorized by the instructor. Any science project or individually planned experiment must be approved by the teacher.
5. Know the proper fire- and earthquake-drill procedures.
6. Roll long sleeves above the wrist. Long, hanging necklaces, bulky jewelry, and excessive and bulky clothing should not be worn in the laboratory.
7. Confine long hair during a laboratory activity.
8. Wear shoes that cover the toes, rather than sandals, in the laboratory.
9. Wear appropriate eye protection, as directed by the instructor, whenever you are working in the laboratory. Safety goggles must be worn during hazardous activities involving caustic/corrosive chemicals, heating of liquids, and other activities that may injure the eyes.
10. Splashes and fumes from hazardous chemicals present a special danger to wearers of contact lenses. Therefore, students should preferably wear regular glasses (inside splash-proof goggles, when appropriate) during all class activities or purchase personal splash-proof goggles and wear them whenever exposure to chemicals or chemical fumes is possible.
11. Place books, purses, and such items in the designated storage area. Take only laboratory manuals and notebooks into the working area.
12. Report any accident to the teacher immediately, no matter how minor, including reporting any burn, scratch, cut, or corrosive liquid on skin or clothing.
13. Students with open skin wounds on hands must wear gloves or be excused from the laboratory activity.
14. Eating or drinking in the laboratory or from laboratory equipment is not permitted.
15. Students are not permitted in laboratory storage rooms or teachers' workrooms without the approval of the teacher.

Handling Equipment

16. Inform the teacher immediately of any equipment not working properly.
17. Report broken glassware, including thermometers, to the instructor immediately.
18. Operate electrical equipment only in a dry area and with dry hands.
19. When removing an electrical plug from its socket, pull the plug, not the electrical cord.
20. When heating material in a test tube, do not look into the mouth of the tube or point it in the direction of any person during the process.
21. When working with lasers or apparatus that produce X rays, microwaves, or ultraviolet rays, make certain that proper shielding and other precautions are used.
22. Know the location and operation of the emergency shower, eyewash and facewash fountain, fire blanket, fire extinguisher, fire alarm box, and exits.
23. Light gas burners only as instructed by the teacher. Be sure no volatile materials (such as alcohol or acetone) are being used nearby.
24. Use a burner with extreme caution. Keep your head and clothing away from the flame and turn it off when not in use.

25. Use a fire blanket to extinguish any flame on a person (see "stop, drop, and roll" procedure in Chapter 2, section C).
26. Use the fume hood whenever noxious, corrosive, or toxic fumes are produced or released.
27. To cut small-diameter glass tubing, use a file or tubing cutter to make a deep scratch. Wrap the tubing in a paper towel before breaking the glass away from you with your thumbs. Fire polish all ends.
28. When bending glass, allow time for the glass to cool before further handling. Hot and cold glass have the same visual appearance. Determine whether an object is hot by bringing the back of your hand close to the object.
29. Match hole size and tubing when inserting glass tubing into a stopper. If necessary, expand the hole first by using an appropriate size cork borer. Lubricate the stopper hole and glass tubing with water or glycerin to ease insertion, using towels to protect the hand. Carefully twist (never push) glass tubing into stopper holes.

Handling Chemicals

30. Check labels and equipment instructions carefully. Be sure correct items are used in the proper manner.
31. Be aware if the chemicals being used are hazardous. Know where the material safety data sheet (MSDS) is and what it indicates for each of the hazardous chemicals you are using.
32. Never pour reagents back into bottles, exchange stoppers of bottles, or lay stoppers on the table.
33. When diluting acids, always pour acids into water, never the reverse. Combine the liquids slowly while stirring to distribute heat buildup throughout the mixture.
34. Keep hands away from face, eyes, and clothes while using solutions, specimens, equipment, or materials in the laboratory.
35. To treat a burn from an acid or alkali, wash the affected area immediately with plenty of running water. If the eye is involved, irrigate it at the eyewash station without interruption for 15 minutes. Report the incident to your instructor immediately.
36. Never carry hot equipment or dangerous chemicals through a group of students.
37. Use a mechanical pipette filler (never the mouth) when measuring or transferring small quantities of liquid with a pipette.
38. Never taste anything or touch chemicals with the hands unless specifically instructed to do so.
39. Test for odor of chemicals only by waving your hand above the container and sniffing cautiously from a distance.

Cleanup and Disposal

40. Be sure all glassware is clean before use. Clean glassware thoroughly after use. Residue may cause errors in new experiments or cause a violent reaction or explosion.
41. Keep work areas clean. Floors and aisles should be kept clear of equipment and materials.
42. Clean up any spill on the floor or work space immediately.
43. Dispose of laboratory waste as instructed by the teacher. Use separate, designated containers (not the wastebasket) for the following:
    - Matches, litmus paper, wooden splints, toothpicks, and so on
    - Broken and waste glass
    - Rags, paper towels, or other absorbent materials used in the cleanup of flammable solids or liquids
    - Hazardous/toxic liquids and solids
44. Remove all broken glass from the work area or floor as soon as possible. Never handle broken glass with bare hands; use a counter brush and dustpan.
45. Always clean the laboratory area before leaving.
46. Students and teacher wash hands with soap and water before leaving the laboratory area.

Note: Persistent or willful violation of the regulations will result in the loss of laboratory privileges and possible dismissal from the class.

Please see the "Student Safety Contract—Physical Science" on the following page.

Student Safety Contract—Physical Science

School: ______________________ Teacher: ______________ Date: __________

Student's name: ____

The student has received specific instruction regarding the use, function, and location of the following:

Aprons, gloves	☐
Chemical-spill kit	☐
Eye-protective devices (goggles, face shield, safety shield)	☐
Eyewash fountain, drench spray, and drench shower	☐
Fire extinguisher	☐
Fire blanket	☐
First-aid kit	☐
Heat sources (burners, hot plate, microwave) and techniques in their use	☐
Material safety data sheets (MSDSs)	☐
Waste-disposal containers for glass, chemicals, matches, paper, wood	☐

The student will abide by the "Physical Science Laboratory Regulations" to prevent accidents and injury to herself or himself and others and will:

- Follow all additional instructions given by the teacher.
- Conduct herself or himself in a responsible manner at all times in the laboratory.

List below any special allergies or sensitivities (e.g., to plants, animals, pollen, foods, chemicals, bee stings) that may affect the student's safety in the laboratory or on field trips:

____

Check this box if the student wears contact lenses: ☐

Student's Statement

I have in my possession and have read the "Physical Science Laboratory Regulations" (pages 167–68) and agree to abide by them at all times while in the laboratory. I have received specific safety instruction as indicated above.

________________________________ ______________

Signature of student Date

Parent's or Guardian's Statement

I have read the "Physical Science Laboratory Regulations" (pages 167–68) and give my consent for the student who has signed the preceding statement to engage in laboratory activities using a variety of science equipment and materials, including those described. I pledge my cooperation in urging that she or he observe the safety regulations prescribed.

________________________________ ______________

Signature of parent or guardian Date

Return the completed and signed form to ______________________ *by* ____________.

APPENDIX Q

SAFETY PRECAUTIONS FOR ROCKET LAUNCHINGS ON SCHOOL SITES

State fire laws now allow model rockets to be launched on school sites provided that the conditions outlined in this appendix are observed.

Activities involving the firing of rockets must be well planned. It is recommended that launchings be limited to no more than ten rockets if an audience will be present. Only authorized classes and clubs may engage in this kind of activity.

Guidelines for the firing of model rockets on school sites are as follows:

1. *Purpose.* These regulations have been prepared for the purpose of establishing reasonable safety standards for the testing and flying of model rockets. Model rockets are classified as nonprofessional rockets that are propelled by approved, commercially manufactured solid propellant engines.
2. *Special permit.* At least four weeks before the date selected for the firing of model rockets, the school shall submit a firing request to the responsible district office. A special permit shall be obtained from the fire department for a given period. (Usually, the fire department's policy is to issue such a permit to cover a brief time.) The permit is issued in the name of the school administrator. The instructor shall comply with all safety standards and conduct the launching in a manner that is also acceptable to the school administrator.
3. *Size of rockets.* Rockets with a class A or smaller engine are strongly recommended. Configuration of the rockets is not limited except for weight (four ounces [112 gm] with engine) and length (not less than ten inches [25 cm] or greater than 15 inches [38 cm]). The rocket shall contain no metal parts.
4. *Launch site standards.* The following stipulations apply:
   a. The launch site shall consist of a firing area and a recovery area. The firing area shall be considered that area contained within a radius of 25 feet (8 m) from the location of the launching platform. The recovery area shall include the firing area and shall be determined to be the minimum area necessary in which to retrieve the launched rocket.
   b. The minimum size of the launch site shall extend to a radius of at least 100 feet (30 m) from the firing position.
   c. The launch site shall not be located in a grain field, in an area of dry grass or bush, or in a forested area.
   d. The launch site shall not contain or be located near any high-voltage line, major highway, or any other obstacle deemed hazardous by the fire department.
   e. The launch site shall not include any buildings or other structures, unless approved by an official from the fire department.
   f. The firing area shall not be closer than 25 feet (8 m) from the boundary of the launch site.
5. *Launching facilities.* Model rockets shall be launched only from platforms that meet the following conditions:
   a. A launch guide (tube, wire, or other suitable device) shall be used to restrict the horizontal motion of the rocket until sufficient flight velocity is achieved to maintain stability during flight. Ignition of the model rocket engine shall be by remote electrical means and shall be under the control only of the person launching the rocket. The launch shall be properly supervised by the instructor in charge.
   b. The launching angle shall not be less than 75 degrees from the horizontal plane.
   c. The surface wind at the launch site shall not exceed 18 miles per hour (30 km per hour), and vertical visibility from the firing area shall be at least 715 yards (650 m).
   d. The recovery device material (parachute or other) ejected from the rocket during the flight sequence shall be of flame-resistant material.
   e. The model rocket shall be launched only during daylight hours (except when specifically approved otherwise by the fire department).
   f. All personnel conducting or observing the firing shall maintain a clear distance of not less than 25 feet (8 m) from the launch platform during the countdown and firing. The firing site shall be clearly blocked off by rope or some other temporary measure.
   g. Only one source of power shall be used for each launch site. No vehicles shall be within the firing area.

h. The person launching the rocket shall make all electrical connections at both the firing platform and the source of power.

i. All spectators shall be positioned upwind of the firing areas and at a distance of at least 25 feet (8 m) from the firing site.

6. *Supervision.* The instructor in charge of the firing site shall supervise the arming of the rocket with the rocket engine, the firing of the rocket, and the disposing of all unfired or defective rocket engines. A second adult shall be responsible for the safety of spectators and all other persons who may be present.

7. *Misfires.* After any misfire the rocket shall be allowed to remain in the launch position for at least one full minute before the rocket is approached. All disarming shall be performed under the supervision of the instructor in charge. The person checking the misfire shall wear a face shield.

APPENDIX R

SAMPLE

PERMISSION SLIP: FIELD TRIP

School: ____________________ Teacher: ____________________ Date: ______________

Student's name: ____________________________ Subject: ____________________________

A field trip has been scheduled for the class, which includes the student named above, on (date)______________. Transportation is by (bus, etc.) ______________ , which will leave the school at __________ (a.m./p.m.) and return at approximately __________ (a.m./p.m.). The field activities will take place at (location) ______________________________.

The purposes of the trip are as follows:

____

____

____

Each student will be expected to:

____

____

____

Dress requirements/options are as follows:

____

____

____

Possible hazards and necessary precautions are as follows:

____

____

____

List below any special allergies or sensitivities (e.g., to plants, animals, pollen, foods, chemicals, bee stings) or other concerns you may have that might affect the student's safety on the field trip:

____

____

____

Parent's or Guardian's Statement

I have read the description of the proposed field activity noted above and give my consent for this student to engage in the field trip.

I pledge my cooperation in making her/him aware of the precautions, as necessary, and in urging that she/he observe the precautions and any other instructions during the trip.

____

Signature of parent or guardian Date Telephone number

Return the completed and signed form to ______________________ *by* __________.

APPENDIX S

OUTBREAKS OF COCCIDIOIDOMYCOSIS ASSOCIATED WITH FIELD WORK

Recommendations for Prevention from the California Department of Public Health

There has been increasing public health concern about outbreaks of coccidioidomycosis (valley fever) among archaeology students in California. The purpose of this statement is to place the problem in its proper perspective and to list precautions which we feel should be taken to help prevent future outbreaks.

On November 24, 1970, the Bureau of Communicable Disease Control, State Department of Public Health, wrote anthropology departments of California colleges that susceptible students and faculty were at risk of acquiring coccidioidomycosis on archaeologic expeditions and suggested that this risk be made known to all who might participate in field work in areas in which the disease is endemic.

Additional outbreaks of coccidioidomycosis have occurred in California among archaeology students since then. Illness rates have exceeded 50 percent in several student groups, and serious disseminated diseases (which required protracted hospitalization and treatment) occurred in a few instances. Outbreaks have continued to occur year after year at sites known to be contaminated with the fungal agent causing coccidioidomycosis.

Coccidioidomycosis can be contracted by minimal exposure to dusty soil in contaminated areas. Almost all of the millions of people who are lifetime residents in these areas eventually develop infection from, and a lifetime immunity to, the soil fungus. However, when groups of persons from noncontaminated areas enter contaminated areas to engage in field activities which include excavation, particularly archaeological digging, a high infection and illness rate can result from a relatively brief exposure.

Therefore, we recommend the following to all school programs engaged in *any* field work involving exposure to dusty soil in areas in which coccidioidomycosis is endemic:

1. No educational institution should require students or faculty to participate in field work in areas in which coccidioidomycosis is endemic. Alternative course work should be considered to satisfy course requirements.
2. Information on coccidioidomycosis should be made available to all prospective students and faculty. Recommended references should include at least the following publications:
   a. Loofbourow, J. C., and D. Pappagianis. *Coccidioidomycosis—An Occupational Hazard for Archaeologists.* Society for California Archaeology, Special Report No. 2, December, 1971.
   b. *Coccidioidomycosis (or Valley Fever).* Sacramento: California State Department of Public Health, 1969.

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APPENDIX T

DISPOSAL OF EMPTY CONTAINERS

The *California Code of Regulations, Title 22*, Section 66261.7, addresses the issue of contaminated containers and encourages recycling and other options for disposal of "empty" containers. Containers once filled with hazardous waste can be disposed of as nonhazardous waste *provided certain stipulations are met.*

Definition of *empty container:*

1. If the container was used to store a hazardous liquid, the container must be completely drained so that no liquid drips from the container when it is tilted or held upside down.
2. If the container was used to store a solid or nonpourable hazardous material (powders, sludges, grease, thick resins), the material must be completely scraped out, leaving no remaining buildup inside the container.
3. Aerosol containers are *empty* if the contents and pressure are completely dispensed; the spray mechanism is in place and is not defective; and the container is not a reactive waste (i.e., may explode).

Please note: Containers that held a listed extremely hazardous material must be managed as hazardous waste or you must obtain authorization from the Department of Toxic Substances Control to triple rinse or treat the container.

Disposal/Recycle Options for "Empty" Container

	Container Type and Size				
Disposal options for empty containers	**Empty container 5 gallons or less in size**	**Empty container greater than 5 gallons in size**	**Empty aerosol can**	**Absorptive container (wood, paper bag, etc.) which has not absorbed any hazardous material**	**Empty compressed gas cylinder (at atmospheric pressure)**
To the original *supplier* for refilling	OK	OK	—	OK	OK
To a *drum reconditioner*	OK	OK	—	—	—
To a *scrap metal/plastic* or other legitimate authorized recycling facility	OK	OK	OK	OK	OK (Remove valve stem.)
To a *solid-waste facility** (top of container must be removed and appointment may be needed for bulk amounts)	OK	No No container greater than 5 gallons will be accepted at local landfills.	OK Spray nozzle must be in place.	OK	OK (Remove valve stem.)
To a *hazardous waste* disposal facility (TSDF)	Required if container is not "empty"	OK	Required if spray nozzle is broken or the can is not empty	Required if hazardous material is absorbed into container	Required if cylinder is not empty

*Recycling options should be considered first. Use a solid-waste facility (landfill) only as a last resort.

Transportation and packaging of the empty containers must be in accordance with applicable State of California, Department of Transportation (DOT) and Department of Toxic Substances Control (DTSC) regulations.

The following additional requirements must be met for "empty" containers greater than five gallons in capacity:

1. The container shall be marked with the date on which it was emptied.
2. The container shall be managed within one year of being emptied.
3. The generator shall provide the name, street address, mailing address, and telephone number of the facility to which the "empty" container has been shipped. The generator shall maintain this information on site for three years.

SELECTED REFERENCES

Note: **Procedures discussed in this handbook involve potential dangers to persons, animals, and other living things and, therefore, should be performed only by persons who are technically trained and qualified.**

SELECTED REFERENCES

Accrocco, J. O., and R. A. Roy. *Right-to-Know Pocket Guide for School and University Employees.* Schenectady, N.Y.: Genium Publishing Corp., 1990.

Excellent, quick reference for addressing right-to-know guidelines and requirements.

Benedict, R. *New Chemicals for Old: Preserving the Student Laboratory Experiment.* St. Paul: Minnesota Department of Education, 1987.

Byrnes, J. K. "Eyewear: Contact Lenses Are Dangerous in the Laboratory," *Campus Safety Newsletter* (Fall, 1988).

Discusses some of the hazards of wearing contact lenses in science settings and some considerations in their use.

Byrnes, J. K. "Eyewear Meets the Challenge," *Safety and Health*, Vol. 134, No. 3 (March, 1989), 64, 67–69.

Answers many of the questions concerning safety goggles, face shields, and other science laboratory eyewear.

Cronin-Jones, L. "Is Your School a Dumping Ground?" *The Science Teacher*, Vol. 59 (October, 1992), 26–31.

Excellent article discussing the problems associated with storage of chemicals in schools and options for disposal.

DiBerardinis, L. J., and others. *Guidelines for Laboratory Design: Health and Safety Considerations* (Second edition). New York: John Wiley & Sons, Inc., 1992.

Comprehensive reference addressing laboratory design; laboratory support services; administrative procedures; and heating, ventilation, and air conditioning systems.

Fiske, J. R. "The Chemical Hygiene Officer: Piecing Together the Liability Puzzle," *Chemical Health and Safety*, Vol. 1 (June/July, 1994), 12–16.

Addresses many of the most common liability questions of chemical hygiene officers.

Fuller, T. C., and E. McClintock. *Poisonous Plants of California.* Berkeley: University of California Press, 1987.

Gerlovich, J., and T. Gerard. "Don't Let Your Hands-on Science Program Blow Up in Your Face," *American School Board Journal*, Vol. 176 (May, 1989), 40–41.

Excellent article outlining the necessity for cooperative efforts between the administration and teachers to ensure a safe science teaching and learning environment.

Guide to Hazardous Substances Reporting Requirements. Sacramento: California Environmental Protection Agency, 1991.

Guidelines for Self-Assessment of High School Science Programs (Revised edition). Arlington, Va.: National Science Teachers Association, 1989.

Provides science teachers with a tool for assessing working conditions.

Guidelines for Self-Assessment of Middle-Junior High School Science Programs (Revised edition). Arlington, Va.: National Science Teachers Association, 1989.

Provides science teachers with a tool for assessing working conditions.

Hall, S. K. *Chemical Safety in the Laboratory.* Boca Raton, Fla.: CRC Press, 1993.

Excellent, comprehensive reference addressing OSHA laboratory standards, chemical hygiene plan, general safety practices, protective equipment, hazardous chemical identification, chemical storage, laboratory ventilation, chemical monitoring, chemical emergencies, chemical waste management, employee training, and recordkeeping.

Handbook of Chemical and Environmental Safety in Schools and Colleges. The Forum for Scientific Excellence. Philadelphia: J. P. Lippincott, 1991.

Addresses the OSHA Hazard Communication Standard, chemical handling, employee safety, hazardous chemical classes, chemical interactions, chemical storage, and legal liabilities.

Horn, Toby M. *Working with DNA and Bacteria in Precollege Science Classrooms.* Reston, Va.: National Association of Biology Teachers (NABT), 1993.

Excellent as a guide for using bacteria and performing DNA experiments safely in high school laboratories.

Improving Safety in the Chemical Laboratory: A Practical Guide (Second edition). Edited by J. A. Young. New York: John Wiley & Sons, Inc., 1991.

Excellent publication covering laboratory organization, MSDSs, safety inspections, federal regulations for laboratories, air sampling of laboratories, and disposal of chemicals.

Mayo, D. W., and others. *Microscale Organic Laboratory with Selected Macroscale Experiments* (Third edition). New York: John Wiley & Sons, Inc., 1994.

The Merck Index: An Encyclopedia of Drugs, Chemicals, and Biologicals (Twelfth edition). Edited by S. Budavari and others. Rahway, N.J.: Merck & Co., Inc., 1996.

An essential reference for all educators who work with chemicals, drugs, biological stains, and so forth. Includes information about the chemical abstract name, alternate names, molecular formula/weight/percent composition, references, structure, physical data, derivatives, use, therapeutic categories, indices.

Microscale Experiments for the High School Chemistry Class. (Public domain experiments developed under an NSF- and Dreyfus-sponsored program.) Available from Woodrow Wilson Foundation, P.O. Box 642, Princeton, NJ 08542; telephone (609) 924-4666.

Mills, J. L., and M. D. Hampton. *Microscale Experiments for General Chemistry* (Second edition). New York: McGraw-Hill, Inc., 1991.

Model Chemical Hygiene Plan for Kentucky School Districts. Lexington: Kentucky Science and Technology Council, Inc., 1991.

Motz, L. L., and G. M. Madrazo, Jr. *Sourcebook for Science Supervisors* (Fourth edition). Arlington, Va.: National Science Teachers Association, 1993.

Excellent reference for science supervisors; encompasses trends for the 1990s, science supervision, the supervisor's role, safety in laboratory settings, evaluation programs, and applied research.

The No Waste Lab Manual—A Procedure That Eliminates Toxic Waste Production from Introductory Chemistry Laboratory Courses. Sacramento: California Department of Health Services, 1989.

NSTA Handbook, 1994-95. Arlington, Va.: National Science Teachers Association, 1994.

OSHA CD-ROM (OSHA A93-4). Washington, D.C.: U.S. Department of Labor, Occupational Safety and Health Administration, 1993. Compact disc.

Excellent reference of ongoing OSHA guidelines and requirements.

Phillips, L., and J. Gerlovich. *50 Safe Physical Science Activities for Teachers.* Skokie, Ill.: Sargent-Welch Scientific Co., 1988.

Excellent teacher's reference of activities in all classes of the physical sciences. All activities are based on integral science safety procedures.

Planning and Managing Dissection Laboratories. Arlington, Va.: National Science Teachers Association, 1994.

Encourages careful planning to ensure optimum learning in dissection lessons. Includes alternatives to dissection.

Prudent Practices in the Laboratory: Handling and Disposal of Chemicals. Washington, D.C.: National Academy Press, 1995.

The Responsible Use of Animals in Biology Classrooms, Including Alternatives to Dissection. Reston, Va.: National Association of Biology Teachers, 1990.

Includes lessons showing responsible use of animals in instruction and reflects the policy of encouraging the use of alternatives to dissection, whenever possible.

Safe Laboratories: Principle, Practices, Design, Remodeling. Edited by P. C. Ashbrook and M. M. Renfrew. Boca Raton, Fla.: Lewis Publishers, 1991.

Deals with design of laboratories from the user's, architect's, and safety professional's perspectives. Includes such topics as ventilation plumbing, chemical waste, fume hoods, and general laboratory renovations.

Safe Storage of Laboratory Chemicals (Second edition). Edited by D. A. Pipitone. New York: John Wiley & Sons, Inc., 1991.

Excellent resource addressing federal regulations on storage of laboratory chemicals, labeling, emergency responses, inspections of academic storage facilities, and disposal of chemicals.

Saunders, G. T. *Laboratory Fume Hoods: A User's Manual.* New York: John Wiley & Sons, Inc., 1993.

Explains room air patterns, hood design, face velocities, system design, and discipline in the use of the hood.

Science Facilities Design for California Public Schools. Sacramento: California Department of Education, 1992.

Assists school personnel and architects in the design of new facilities to allow for the expansion of activity-based lessons and additional science courses as recommended in the Department's *Science Framework.*

Science Framework for California Public Schools, K–12. Sacramento: California Department of Education, 1990.

Science Safety—No Game of Chance: A School Science Safety Manual. Tallahassee: Florida Department of Education, 1992.

Excellent, general science safety tool.

Steel, M.; P. Conroy; and J. Kaufman. "How to Say 'No' to Overcrowded, Unsafe Science Labs," *NSTA Reports* (April, 1993).

Excellent publication for addressing one of the most often-asked safety questions of science teachers.

Thompson, S. *Chemtrek: Small-Scale Experiments for General Chemistry.* Englewood Cliffs, N.J.: Prentice Hall, 1990.

Working Conditions for Secondary Science Teachers. Washington, D.C.: National Science Teachers Association, 1986.

Provides an excellent synopsis of general conditions for safe science teaching.

Publications Available from the Department of Education

This publication is one of over 700 that are available from the California Department of Education. Some of the more recent publications or those most widely used are the following:

Item no.	Title (Date of publication)	Price
1537	Arts Education Program Toolkit: A Visual and Performing Arts Program Assessment Process (2001)	$13.25
1372	Arts Work: A Call for Arts Education for All California Students: The Report of the Superintendent's Task Force on the Visual and Performing Arts (1997)	11.25
1379	Assessing and Fostering the Development of a First and a Second Language in Early Childhood—Training Manual (1998)	19.00
1377	Assessing the Development of a First and a Second Language in Early Childhood: Resource Guide (1998)	10.75
1467	Aviation Education and Technology Resources for Teachers (2000)	15.00
1356	Best Practices for Designing and Delivering Effective Programs for Individuals with Autistic Spectrum Disorders (1997)	10.00
1450	C.A.F.E.—Cafeteria Access for Everyone (video and guide) (1998)	14.00
1436	California Department of Education Early Start Program Guide (1998)	10.00
1530	California Private School Directory, 2000-01	17.50
1529	California Public School Directory, 2001	19.50
1535	California Safe Schools Assessment 1999-2000 Results: Promoting Safe Schools (2001)	24.00
1504	California School Accounting Manual, 2000 Edition	25.00
1373	Challenge Standards for Student Success: Health Education (1998)	10.00
1409	Challenge Standards for Student Success: Language Arts Student Work Addendum (1998)	12.75
1435	Challenge Standards for Student Success: Physical Education (1998)	8.50
1429	Challenge Standards for Student Success: Visual and Performing Arts (1998)	12.50
1290	Challenge Toolkit: Family-School Compacts (1997)	9.75*
1439	Check It Out! Assessing School Library Media Programs: A Guide for School District Education Policy and Implementation Teams (1998)	9.25
1466	Children Teaching Children II (CD-ROM) (1999)	12.00
1491	Collaborative Partners: California's Experience with the 1997 Head Start Expansion Grants (2000)	12.50
1525	College Students Working in After-School and School-Age Care Programs: A Guide for College Students (2001)	10.50
1285	Continuity for Young Children (1997)	7.50
1543	Coordinated Compliance Review Training Guide, 2002-2003 (2001)	22.00
1410	Ear-Resistible: Hearing Test Procedures for Infants, Toddlers, and Preschoolers, Birth Through Five Years of Age (1998)	10.00
1352	Educational Specifications: Linking Design of School Facilities to Educational Program (1997)	18.50
1476	Educating English Learners for the Twenty-First Century: The Report of the Proposition 227 Task Force (1999)	10.50
1509	Elementary Makes the Grade! (2000)	10.25
1389	English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve (1998)	9.25
1468	Enrolling Students Living in Homeless Situations (1999)	8.50
1244	Every Child a Reader: The Report of the California Reading Task Force (1995)	5.25
1430	Every Little Bite Counts: Supporting Young Children with Special Needs at Mealtime (1998)	14.75
1367	Family Connections: Helping Caregivers Develop Nutrition Partnerships with Parents (1997)	9.00
1475	First Class: A Guide for Early Primary Education, Preschool–Kindergarten–First Grade (1999)	12.50
1388	First Look: Vision Evaluation and Assessment for Infants, Toddlers, and Preschoolers, Birth Through Five Years of Age (1998)	10.00
0804	Foreign Language Framework for California Public Schools, Kindergarten Through Grade Twelve (1989)	7.25
1355	The Form of Reform: School Facility Design Implications for California Educational Reform (1997)	18.50
1378	Fostering the Development of a First and a Second Language in Early Childhood: Resource Guide (1998)	10.75
1382	Getting Results, Part I: California Action Guide to Creating Safe and Drug-Free Schools and Communities (1998)	15.25
1493	Getting Results, Part II: California Action Guide to Tobacco Use Prevention Education (2000)	13.50
1482	Getting Results, Update 1, Positive Youth Development. Research, Commentary, and Action (1999)	12.00
1408	Guide and Criteria for Program Quality Review: Elementary Grades (1998)	13.50
1465	Handbook on Administration of Early Childhood Special Education Programs (2000)	13.50
1463	Handbook on Assessment and Evaluation in Early Childhood Special Education Programs (2000)	13.50
1517	Handbook on Developing and Implementing Early Childhood Special Education Programs and Services (2001)	13.50
1521	Handbook on Developing Individualized Family Service Plans and Individualized Education Programs in Early Childhood Special Education (2001)	13.50
1464	Handbook on Family Involvement in Early Childhood Special Education Programs (1999)	11.25
1380	Health Careers Education 2000: A Program Guide (1998)	20.00

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* Other titles in the *Challenge Toolkit* series are *Outline for Assessment and Accountability Plans* (item no. 1300), *Safe and Healthy Schools* (item no. 1299), *School Facilities* (item no. 1294), *Site-Based Decision Making* (item no. 1295), *Service-Learning* (item no. 1291), *Student Activities* (item no. 1292), and *Student Learning Plans* (item no. 1296). See page 180 for complete information on payment, including credit card purchases, and an order blank.

Prices are subject to change. Please call 1-800-995-4099 for current prices and shipping charges.

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Item no.	Title (Date of publication)	Price
1064	Health Framework for California Public Schools, Kindergarten Through Grade Twelve (1994)	$10.00
1477	Helping Your Students with Homework (1999)	9.25
0737	Here They Come: Ready or Not—Report of the School Readiness Task Force (summary report) (1988)	5.00
1488	History–Social Science Content Standards for California Public Schools, Kindergarten Through Grade Twelve (2000)	9.00
1531	History–Social Science Framework for California Public Schools, Kindergarten Through Grade Twelve, 2001 Updated Edition with Content Standards (2001)	13.50
1245	Improving Mathematics Achievement for All California Students: The Report of the California Mathematics Task Force (1995)	5.25
1500	Independent Study Operations Manual (2000 Edition)	30.00
1258	Industrial and Technology Education: Career Path Guide and Model Curriculum Standards (1996)	17.00
1024	It's Elementary! Elementary Grades Task Force Report (1992)	9.00
1442	Joining Hands: Preparing Teachers to Make Meaningful Home-School Connections (1998)	13.25
1486	Kids' Time (Spanish) (El Horario de los Niños) (2000)	14.95
1266	Literature for the Visual and Performing Arts, Kindergarten Through Grade Twelve (1996)	10.25
1457	Mathematics Content Standards for California Public Schools, Kindergarten Through Grade Twelve (1999)	8.50
1508	Mathematics Framework for California Public Schools, Kindergarten Through Grade Twelve (2000 Revised Edition)	17.50
1213	Model Program Standards for Adult Basic Education (1996)	11.50
1512	Nutrition to Grow On: A Garden-Enhanced Nutrition Education Curriculum for Upper Elementary School Children (2001)	17.50
1384	Observing Preschoolers: Assessing First and Second Language Development (video) (1998)	12.00
1065	Physical Education Framework for California Public Schools, Kindergarten Through Grade Twelve (1994)	7.75
1314	Positive Intervention for Serious Behavior Problems: Best Practices in Implementing the Hughes Bill (Assembly Bill 2586) and the Positive Behavioral Intervention Regulations (Revised Edition) (1998)	14.00
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